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Appreciated Illustrations. THE fact that the illustrations in the columns of THE ELECTRICAL WORLD are interesting and useful to the profession is shown very well by a single order just received by our electrotyper, from an outside source, for 230 reproductions of a large number of cuts published in our columns within the past two months. These were all new and were published exclusively in this journal. No better proof of the valuable nature of the matter published in THE ELECTRICAL WORLD could be wished for.

Are Our Theories Prisons? THERE appears to be more truth than fiction in the remark made by Mr. Thos. D. Lockwood at the recent annual dinner of the Institute of Electrical Engineers to the effect that modern theories of electricity and electrical phenomena, if allowed to become the framework of all our knowledge of these subjects, may in a few years be the prison bars that will prevent the mind from making a free and unprejudiced investigation of new theories and new phenomena, and assigning to their due place in the general science of electricity whatever results the most recent experimenters may obtain. Of course, Mr. Lockwood did not mean to say that the student must not consider carefully the theories of the day, because these were likely to be exploded in a few years, but rather that all theories are merely tentative, and that they must not be regarded as fixed and unchangeable laws of science. The student of modern science must be what every great scientific investigator has been and must of necessity be, a judicious doubter. "He who doubts not fails" probably applies with greater emphasis in the domain of science than in any other branch of learning, and the proper attitude for the student is to regard the present theories merely as stepping stones to more comprehensive and more satisfactory ones, rather than to allow any theory, however plausible, to prevent the ready investigation and, if need be, acceptance of any other.

The New Unit, Kelvin. THE English Board of Trade has just decided that the commercial unit of electricity formerly known as the "Board of Trade unit" is hereafter to be called a "kelvin." The unit itself is one kilowatt hour, that is, 1,000 watt hours, and its new name is the present title of the well-known Sir William Thomson, now Lord Kelvin. Some people object to naming units, but they fail to give any good reasons and are quite ready to make use of such units when they find out the time, paper, ink and patience it saves to replace a sentence by a single word. Their unfavorable criticisms need not, therefore, be considered. No one can object to the well-deserved honor done to Sir William Thomson by thus naming an important electrical unit; it seems a pity though that the name "kelvin" was chosen in place of "thomson," as that eminent gentleman has gained his world wide fame under the latter name and many will never know who the present name, kelvin, refers to. But the unit has been named by parties who have doubtless considered all the points, and our best plan is to join hands with our English friends and adopt with them this new name in the same way that they accepted our unit, the henry. The coming Congress in 1893 would do well to officially adopt this name and stop all petty disputes which may arise between others who think that their views must be the only correct ones. Those who object may still continue to write the euphonious name "kilowatt-hours;" nobody but they themselves and their stenographers are the losers.

Designing Transformers. WE publish in another column an article on transformers by M. Dobrowolsky which cannot fail to be of interest and instruction to those who are working in this field. The unique treatment of the subject must commend itself to many. The writer, who would be quite able to treat the subject in a theoretical manner, prefers to set aside all abstruse and complicated methods, and comes down to very simple and practical principles, which any one can understand without a knowledge of mathematics or practice in more scientific but often less intelligible and less useful methods. The fundamental law regarding the magnetism generated by alternating currents, which he gives and was, doubtless, the first to state in that form, is quite universal and eminently practical; it simplifies greatly the treatment of this subject and could often be applied to advantage in considering the problems which come up in practice. The practical deductions given by him, which follow from this law when applied to transformers, will alone show the advantage of such a treatment of the subject. Being actively engaged in the practical designing and construction of machinery, he considers the matter from the standpoint of the practical engineer; the results are therefore of value, besides being interesting. One objection to the nature of the matter published on alternating currents so far has often been that many of the authors, being capable themselves, have assumed too much knowledge on the part of the readers, and therefore many who would like to read and understand such articles have been barred from doing so. What is needed in this branch of electrical literature is a clear practical treatment of the subject. A former paper by this same author, published in these columns last year, is also of the same character and is well worth reading.

The Neversink Mountain Electric Road. IN the present issue we begin a series of articles about a very interesting and quite unique electric railroad on the Neversink Mountain, near Reading, Pa. Being a mountain road, and having its current generated entirely by water power, alone would make it of interest, but besides this the article includes more particularly a very complete description of a most thorough series of tests of this road made by capable and uninterested parties. These tests were solicited by THE ELECTRICAL WORLD, and the results were prepared especially for our columns. They cover the ground in a most thorough manner, and are doubtless the most complete and carefully made set of tests ever published, and perhaps ever made, of an electric road. Some of the diagrams to be published are very instructive, showing simultaneous readings on various parts of the whole circuit, from the water of the turbine to the car. Being made by impartial parties, there is not the usual suppression of any unfavorable features, which is so often found in articles prepared in the interests of the builders. As an illustration of one of the points brought out, the tests showed that coupling two turbines in multiple arc with each other, so to speak, using the method of regulation adopted there, is very bad practice, because, under certain circumstances, one turbine will drive the other, giving, therefore, a negative efficiency for the latter. The curves showing the working of the turbines and other features regarding them have been stated by some hydraulic experts to be of a very interesting, novel and useful character, much of it covering ground which has never been treated of in journals or books on that subject. Electrical engineers contemplating the introduction of turbines, whether for electric railway work or central lighting stations, will find it profitable to make a thorough study of this report.

Enterprise, Genuine and Bogus. THERE is an old and wise saying that "persons in glass houses should not throw stones," which applies very well to some recent utterances and publications in one of our contemporaries. To any one posted on the literature published in the electrical journals during the past few years, the editorial comments recently made by that contemporary are very amusing, although they were evidently intended to be serious. The parties pose as enterprising journalists, and boast of their great achievement of having recently published and illustrated at their own expense (!) a little novelty which the other journals did not have until a week later. An examination shows that this matter belonged to a class of material which a journal devoting itself to the dissemination of knowledge rather than of amusement treats as second-class matter, which is sometimes crowded out by more important subjects. However, we pride ourselves also on our abilities to publish new matter, if of sufficient importance (as, for instance, the Tesla lecture), for which the readers of some of our contemporaries have to wait a week or two (in one case two years); a list of such cases would be quite interesting were it necessary for us to prove this. It is not our custom to attack our contemporaries, especially not the younger ones, but when attacked by them we can defend ourselves. The one assailing us published recently a series of articles in which it has deliberately copied illustrations from THE ELECTRICAL WORLD, made especially for us by our own artist and published exclusively in these columns nearly two years ago. No acknowledgment was given by this contemporary, on the contrary the artist's name was erased and another name substituted. The fact that some of these illustrations were reversed, or made to appear like a negative of the original, does not make them new matter, nor are they necessarily made more interesting by this process. Neither does the fact that we published them one, and in some cases almost two years ago, make them new or "genuine" matter; they may now be of historical interest on account of their age, but our contemporary fails to point out this historical value. The deadly parallel column in this case would be quite interesting, one headed "Genuine" and the other "Bogus," but a proper acknowledgment on the part of our younger contemporary will, we hope, make this unnecessary.

Comments Made by Our English Cousins. ALTHOUGH the Englishmen often think and talk—or talk without thinking—in an uncomplimentary way about electricity in America, there are some among them who come here unbiased, examine what Americans have done, appreciate what is good, and excuse what is not so, making due allowances for the characteristic differences between the two countries. There is, perhaps, no English electrician who has made a more thorough and impartial study of, and is better posted on American practice than Prof. Forbes, who has visited this country very frequently. In some remarks made a few days ago he complimented the Americans very highly for various characteristic features, but pleasing as such compliments are, let us pass over to one of his criticisms, which, coming as it does from one who is impartial and fair, is well worth taking a lesson from. He stated that Europeans wait for us to develop a new industry, such for instance as electric lighting, but when they do introduce it they do it so thoroughly that we are left far in the rear. A few years ago London had very few electric lights, nothing compared with our American cities; now it far exceeds any of our large cities, not only in the number of lights, but more especially in the thorough, careful, well designed and permanent construction of the plants. They are put up to stay, and to stay for a long time to come. The same, except, perhaps, as to the extent of the lighting, may be said of Berlin and Paris. While in America we were trying to make ourselves think that underground lines were not practicable, there they were introducing nothing else but such wires. Much of the temporary nature of many of our plants is due, however, to the fact that the older installations were often somewhat of an experimental kind; but now that this point is passed, we may well take a lesson from abroad and try to build our plants in the very best manner possible. Much good work of this kind has already been done here and is being done to-day, but there exists still one very great drawback in the want of proper municipal participation in our large cities, without which we can never expect to have such general and complete systems as abroad. We elect city officials whom we cannot trust to govern us. An introduction of some municipal improvement here almost invariably means fat franchises and "boodle" for those in power who give them; frequent change of officers means "make hay while the sun shines." Under such circumstances municipal control of public works must necessarily be unsatisfactory and expensive.

Annual Meeting of the American Institute of Electrical Engineers.

On Tuesday of last week the American Institute of Electrical Engineers held its annual meeting for the election of officers and the transaction of some routine business. In the absence of the president, Mr. T. D. Lockwood, one of the vice-presidents, presided.

The report of the council for the year ending April 30, 1892, was read by the secretary, and is here given in full:

Your council takes pleasure in submitting for your information, in accordance with the rules of the institute, the following report, showing the growth in membership, receipts and disbursements and a brief review of the work of the year ending April 30. It has been the practice heretofore to bring this report down to the date of the annual meeting, but it is more convenient to end the fiscal year with the calendar month, which gives more time to prepare the reports for presentation, and if there appears to be no objection to this practice, the yearly accounts will be closed hereafter on April 30.

Ten regular meetings and one special meeting of the council have been held during the year, at which the average attendance has been 11. The largest number present having been 13 and the smallest 7.

The general meeting of the institute was held in New York City, May 20 and 21, and occupied two days. Eight other meetings have been held. At these various meetings 24 papers and reports were read and discussed, and have since been printed and distributed to the members.

The institute was invited to unite with other engineering societies in the establishment of Engineering Headquarters at Chicago dur ing the Columbian Exposition. As the plans of the Exposition developed, however, it appeared that the proposed electrical congress would require the undivided support of all electrical organizations, and for this reason your council deemed it wise to decline entering into the proposed arrangement. It was subsequently decided that the institute should support the action of the World's Congress Auxiliary in making preparations for the World's Electrical Congress in order to do its share in making the Congress a success.

In accordance with the instructions of a meeting of the institute, the following delegates were appointed by council to represent the institute at the Frankfort Electrical congress in 1891: Messrs. Carl Hering, Nikola Tesla, Prof. Richard O. Heinrich and Dr. Edward L. Nichols. With the exception of Mr. Tesla, all the delegates were in attendance, and their report was duly submitted to coun cil and printed in the Transactions.

At the meeting of February 16 it was decided that the general meeting of 1892 be held at Chicago in order that an opportunity might be offered the Western members of the institute to participate in its proceedings. It was believed that the standing of the institute as a national body would be enhanced by the holding of its meetings in other cities than New York, provided experienc proved that this might be successfully done. The date was subsequently fixed for June 6, 7 and 8.

The total membership at the close of last year's report was 541, as follows: Honorary, 3; members, 161; associate members, 377; total, 541; associate members elected during the year, 111, making a total of 652

The following have resigned during the year: Henry S. Iselin, Thos. B. Kerr, J. Howard Pratt, Jr., A. H. Henderson, W. S. Belding, B. C. Batcheller, H. C. Roome, W. P. Trowbridge, Graham D Fitch; total, 9. We have lost by death: George Worthington, of New York City; Chas. J. Van Depoele, of Lynn, Mass. Elections canceled by reason of failure to qualify, 4; suspended for non-payment of dues, 5; dropped from the list for non-payment of dues, 17, making a total loss of membership, 37. Deducting this loss of membership as stated leaves a remainder of 615 (a net gain of 74), classified as follows: Honorary members, 3; members, 179; associate members, 433; total membership May 1, 1892, 615.

The treasurer has disbursed upon warrants drawn by the secre tary, approved by council and finance committee, the amount of $7,224.89, classified as follows:

Special deposit Mercantile Trust Company, $500; stenography and typewriting, $556.41; stationery and miscellaneous printing, $505 45; postage, $299.95; messenger service, $40.27; salaries, $1,441.67; engraving and electrotyping, $649.14; meeting expenses, $480.10; rent, $600; printing transactions, $1,801.08; express, $4.60; telegrams, $3.61; binding, $170.52; office fittings, $15.38; office expenses, $75.46; copyright, $4.50; duties, $3; extra clerical work, $50; library, $3.75; engrossing, $20; total, $7,224 89. This amount should be credited with the following items: Special deposit, $500; electrotypes sold, $528 31; received for typewriting and stenography, $217.74; received for binding, $20.65; sundry receipts, $6; total, $1,272 70; showing the net expenses of the year to have been $5,952.19, and the net receipts for fees, dues, sales and subscription on account of Transactions, $5,960.43; showing an excess of net receipts over net expenses of $8.24; the outstanding current bills against the institution amount to $191.17, and the amount of uncollected bills from other than members, $305.94.

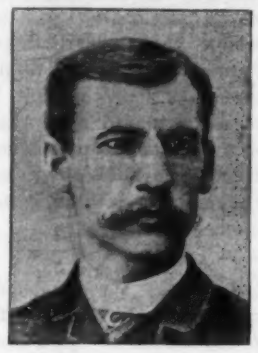
The arrearages of dues for the past year amount to $480, most of which is probably collectable.

In accordance with the instructions of the last annual meeting, the secretary and the treasurer, acting as trustees, made a special deposit of the $350 previously reported as a building fund, also $500 surplus from the general fund, making a total of $850, which has drawn interest at the rate of three per cent. This rate was reduced to two per cent. May 14. The treasurer's cash balance on April 30 was $245.53, and the secretary's cash balance the same date $25:56, making the current balance carried forward to the next year $271.09. Special deposit, $850.

The report of the treasurer, George M. Phelps, showed that the balance May 16, 1891, from the previous year was $752.94; the amount received from the secretary from that date to April 30, 1892, $6,717.48; making a total of $7,470.42. While the payments from May 16, 1891, to April 30, 1892, on warrants from the secretary were $7,224.89, leaving a balance to the new account of $245.53. The balance on hand May 16, 1891, of the building fund was $350, and on July 1, 1891, there was transferred to this account from the general fund $500, so that the total balance on hand in both the general fund and the building fund was $1,095.53.

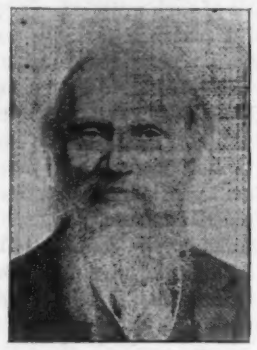
The election resulted in the choice of the following officers: President, Frank J. Sprague; vice-presidents, A. E. Kennelly, Nikola Tesla, Oscar T. Crosby; managers, Charles Wirt, Angus S. Hibbard, Dr. Michael I. Pupin, Charles P. Steinmetz; treasurer, Geo. M. Phelps; secretary, Ralph W. Pope. The officers holding over from last year are as follows: Vice-Presidents, T. D. Lockwood, Carl Hering, Wm. J. Hammer; managers, J. C. Chamberlain, P. B. Delany, H. A. Foster, H. Ward Leonard, Dr. Louis Bell, Herbert Laws Webb, Prof. A. G. Compton and James Hamblet.

Mr. Frank J. Sprague, the new president, is well known as one of the pioneers in electric traction enterprise in this country, and as this is the first time that a representative of this most important branch of electrical applications has held the chair of president of the Institute, Mr. Sprague's election will give general satisfaction. His career as an electrical engineer is too well known to make it necessary for us to give any extended account of his work. His connection with the Sprague Electric Railway and Motor Company, the Edison General Electric Company and the Sprague Electric Elevator Company has brought his work prominently before all who have any interest in the applications of electricity to the operation of stationary and railway motors.



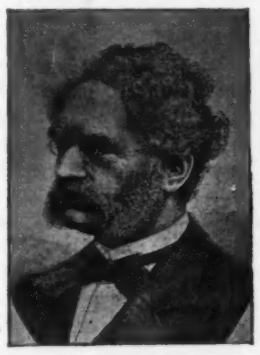
Frank J. Sprague.

A committee was appointed by the chairman to revise the method of electing officers so that all members of the Institute, whether present or not at the annual meeting, might have an opportunity of voting for the officers of the Institute. This committee is to report at the Chicago meeting.



Sir Wm. Thomson.

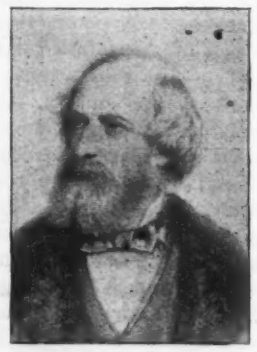
It was announced that at the council meeting in the afternoon three honorary members had been elected; these were Sir William Thomson (Lord Kelvin), Werner Siemens and Cyrus W. Field. These are men whom Americans delight to honor and our readers will be interested in their portraits which we give on this page. The portrait of Cyrus W. Field is from a painting by Daniel Huntington and is reproduced from the *New England Magazine;* that of Siemens is produced from Badt and Carhart's "Practical Electrical Units"; and the portrait of Lord Kelvin is taken from the steel plate supplement of *The Electrician* of London.



Werner Siemens.

The annual dinner of the Institute was held in the evening after the election, and was a very enjoyable affair. About 65 members and guests were present. President Sprague as toastmaster introduced the speakers of the evening, among whom were Messrs. T. D. Lockwood, O. T. Crosby, Chas. E. Emery, T. C. Martin, Geo. Forbes, F. L. Pope, Louis Duncan and Oberlin Smith.

The speeches by Messrs. Crosby, Lockwood and Forbes were especially enjoyable.



Cyrus W. Field.

Among these who attended the dinner from out of town were Dr. Louis Duncan, of Johns Hopkins University; T. D. Lockwood, of Boston; Franklin L. Sheble of Lynn; Elmer Willyoung, of Philadelphia; Mr. James, of Washington; Prof. Geo. Forbes, of London; Mr. Pike, of Philadelphia, and O. T. Crosby, of Boston.

Electric Storm Vagaries.

BY WILLIAM FINN.

In a recent communication to The Electrical World on the subject of earth currents, the writer presented some details regarding the derangement of the telegraph service from the series of electric storms which began Feb. 13 last, and continued with more or less frequency and intensity up to April 26.

Several recurrences of the phenomena have since been noted, and some curious and anomalous results observed. On Monday, May 16, for instance, the entire quadruplex service between New York and Chicago over the Western Union lines was quite seriously interrupted all day by the prevalence of earth currents, which, strange as it may appear, failed to sensibly disturb the more delicate apparatus of the automatic system until after 3 P. M., though that system is usually the first to indicate the fact of their existence in the wires.

The following day was a comparatively quiet one, only a few instances being recorded of interruptions from that cause; but early on Wednesday, May 18, an electric storm of considerable proportions put in an appearance, and continued to rage with varying degrees of violence all day, and during a greater portion of the succeeding night

At first the western wires alone felt the disquieting forces, but toward the afternoon the area of disturbance became greatly extended, and after 3 P. M. circuits in nearly every direction became influenced.

The maximum intensity was reached about four o'clock, at which time an earth current in a wire between Buffalo and Chicago developed a strength of 35 milliampères, representing a potential difference between the two grounds of nearly 90 volts.

Conversation was subsequently carried on between New York and Buffalo, and signals exchanged over wires to Albany, Boston and Bangor by means of these natural currents.

It is a singular fact that at a time when circuits to Philadelphia, Washington, and other comparatively short lines to southern points were almost entirely free from interruption, the longer southern circuits, such as those to Richmond, New Orleans, etc., could only be operated with consider able difficulty and delay.

The most peculiar characteristics of the storm consisted in the variety of its vagaries and the suddenness of its changes.

At one moment the signals on the circuits affected would be rendered entirely unintelligible, while immediately afterward the storm would so far subside as to admit of the ordinary signaling currents passing without any interference whatever.

These alternations of maxima and minima continued with more or less irregularity all day, the phase and period of one wave differing apparently from those of every other.

The only effective remedy against earth current disturbances on land lines appears to be in the use of the metallic circuit. It is possible to entirely exclude them by means of condensers interposed in the line, as is customary on long submarine circuits, but where neighboring wires are more numerous and operated with currents of much greater intensity, the condenser becomes a source of fresh trouble from inductive action, which renders it practically useless in the ordinary transmi ssion of signals.

Orders for More Electric Locomotives.

The Belt Line Tunnel, of Baltimore, which, from a railroad point of view, forms the approach to that city, has been leased to the Baltimore & Ohio Railroad Company. We learn as we go to press that the General Electric Company has just closed a contract to supply three 80-ton electric locomotives to be used to push trains through the tunnel. These electric locomotives will push a freight train of 1,200 tons, including locomotive, through the tunnel from the south end, up an $\frac{8}{10}$ of one per cent. grade, for a distance of 6,000 feet, at the rate of 15 miles an hour, or a 500-ton passenger train, including locomotive, at the rate of 30 miles an hour. The locomotives will naturally be operated from the central station, but the means employed to accomplish this will be of special design. The electric locomotive begins to assume a come-to-stay air.

NEW BOOK.

A Dictionary of Electrical Words, Terms and Phrases. By Prof. Edwin J. Houston. Third edition; 562 double-column pp., 570 ills. Price $5.00. New York. The W. J. Johnston Company, Limited, 1892. (First notice.)

The first edition of this book was published in 1889, and owing to the fact that it was the first electrical dictionary in the English language it was necessarily more or less imperfect in many of its details. Many of the definitions were shorter than was found to be consistent with clearness, and very many of the terms and phrases in general use were found to have been overlooked in its compilation. When the author undertook to prepare the second edition he determined to rewrite almost entirely the first edition, to enlarge many of its definitions, to extend the descriptive matter accompanying illustrations of apparatus, and to insert titles which had been omitted in the first edition as well as hundreds of words which had come into use in the last three years.

The appearance of the new edition is therefore entirely different from that of the first. Its pages are larger and each contains two columns of matter. The cuts are more numerous and of a better quality. The work contains about 5,000 distinct titles under which definitions are given, and in addition to these perhaps 5,000 more entries are made from which the student is directed by cross references to those titles under which the definitions sought for are given. Under most of the titles two styles of type are used; the first and larger size being used for what might be termed the definition proper, while explanatory and descriptive matter which it was thought would add to the value of the book as a work of reference is given in a smalle size of type. The titles themselves are printed in clear, bold-faced type, so that they are the first to catch the eye in glancing over the page. At the top corners of each page are given the first three letters of the first and last titles on the page. This is an addition which those who have used the first edition in which these catch words were omitted will appreciate.

On the whole, the book presents a decidedly substantial appearance, and any one who examines it cannot help noticing the fact that the vocabulary of electrical science is a very extensive as well as progressive one. Wherever the first edition has become a standard book, the new edition will be welcomed as a more convenient as well as more elaborate work of reference.

Ampere-Centimetre, a Measure of Electro-Magnetism.*

BY CARL HERING.

It appears from the following deductions that an electric current multiplied by the length of the circuit will represent the number of magetic lines of force generated by this current, or, in other words, that the number of lines of force generated by a current can be measured by the product of the current and the length of its circuit. A unit current passing through a unit length of circuit appears to generate a certain fixed and constant number of lines of force. This, of course, has reference to the electro-magnetism of the current itself and does not include the influence of any magnetic bodies in the neighborhood.

First of all it is necessary to show that ampères multiplied by length will give a unit of a similar nature to magnetic lines of force or flux, in order to show that an equivalent between the two may be given without transgressing the laws of physics. This may be shown conclusively by the aid of the dimension of these units in the absolute system. The dimension of current is $m^{\frac{1}{2}} l^{\frac{1}{2}} t^{-1}$, while that of magnetic flux (that is, number of lines of force, not their density per square centimetre, usually represented by **H** or **B**, nor the intensity, as it is sometimes called) is $m^{\frac{1}{2}} l^{\frac{3}{2}} t^{-1}$. It will be seen that the former multiplied by a *length* gives the latter. This shows conclusively that ampère-centimetres or ampère-feet and magnetic flux are units of the same kind and can therefore be equated.

Having determined this point, the following appears to show that every unit length of a circuit conveying one ampère generates a fixed and constant number of lines of force. Using absolute units, the intensity of magnetization (or number of lines per square centimetre) at the centre of a circle of one turn, according to the well-known formula, is

$$\mathbf{H} = \frac{2c\pi}{r}$$

in which r is the radius in centimetres and c is the current.

Now, the intensity of the field is different in different parts of the area enclosed by the circle, being greatest nearest to the wire, but it may be assumed that in all circles, large or small, the ratio of the intensity at the centre to the average intensity in the whole circle is a constant. Let this ratio be called K, then the total number of lines will be equal to the intensity at the centre multiplied by the area, and by K; that is

$$M = \frac{2c\pi}{r} \times \pi r^2 \times K = 2c\pi^2 r K$$

Dividing this by the circumference will give the number of lines per unit length of the circuit

$$2c\pi^2 r K \div 2\pi r = C\pi K,$$

or per unit of current this is equal to K. It will be seen that this is a constant and is *independent of the radius r*. This means that the number of lines per unit length and per unit current is the same for all circles, and therefore also for a straight line, which is a circle of infinite radius.

From this it appears that, knowing this constant number of lines per ampère per centimetre or foot, the calculation of the total number of lines generated by any circuit or coil would merely be the product of the current, the length of the circuit, and a constant.

It should be remembered, however, that this deduction supposes theoretical conditions; that is, a filamentary wire having no appreciable diameter. How far the size of the wire introduces an error remains to be determined. At all events, if the diameter of the wire is small as compared with the diameter of the coil, and specially if the coil, as it usually does in practice, contains iron which appears to concentrate the lines in it, and therefore probably attracts those circulating in the body of the wire itself, it may doubtless be assumed that the ratio of the flux in two coils would be equal to the ratio of their ampère feet, which proportion might be of use in dynamo construction.

The above deductions were made by the writer a number of years ago, but as they did not appear to agree with some existing laws at that time the matter was laid aside. It seems, however, that subsequently some dynamo builders have advocated and used this system of calculation in preference to the other, and it was therefore thought best to publish this proof, hoping that some others, well informed on this subject, might point out the discrepancies if any, and perhaps show the extent of the application in practice of calculating the magnetic flux of a current from the ampère-centimetres of the circuit.

* A paper read before the Electrical Section of the Franklin Institute.

Test of the Neversink Mountain Electric Road.—I.

BY HERMANN S. HERING AND WM. S. ALDRICH, OF JOHNS HOPKINS UNIVERSITY.

Descriptive Outline.—This road, built in 1890, is the pioneer among electric railroads operated by turbines. Possessing as it does many unique features of special interest to electric railroad engineers, the authors of this article have conducted a series of tests of the plant and road, at the special request of THE ELECTRICAL WORLD. The tests were made from Aug. 17 to 22, 1891, and comprised three sets of observations and deductions as follows:

(1) Simultaneous observations on the turbines and dynamos to determine their performance and the distribution of the power losses of the plant.

(2) Observations at the power house while the road was carrying a heavy excursion, to determine the performance of the turbines and dynamos under extreme and sudden variations of load, the proportional distribution of power and the working efficiency of the plant.

(3) Simultaneous observations at the power house and in a special car to determine the line resistance, efficiency of transmission, the performance of the car motor on various grades and the combined efficiency from motor terminals to car axle.

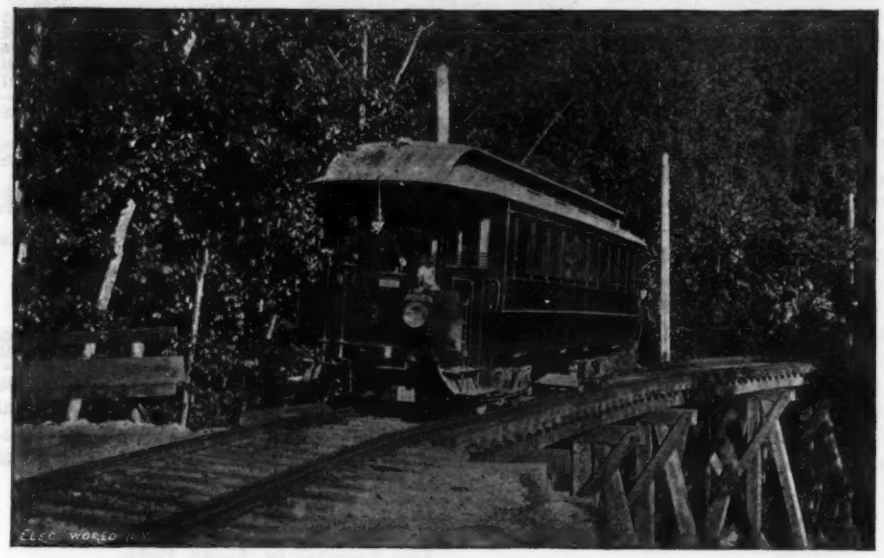


FIG. 3.—VIEW OF CAR ON TRESTLE.

The Neversink Mountain with its electric road, and Mount Penn with its steam and gravity road, lie to the east of the city of Reading, in Berks county, Pa. These railroads, encircling the mountains, rise by varying grades from the streets up the foot slopes, and thence along the mountain sides to the summits, opening up a panorama of most beautiful views of the Schuylkill and Lebanon valleys and the Blue Mountains.

The topography of the Neversink Mountain and the location of its electric railroads are shown in Fig. 1. The city terminal is at Ninth and Penn streets, four blocks from the heart of the city, and easily accessible from the stations of the Pennsylvania and the Philadelphia & Reading railroads. From this terminus the road follows the streets to the city limits and the White House, by varying grades. From the White House the road gradually ascends along the north side of the mountain in view of the city of Reading and the valley between the two mountains. Then after rounding the eastern end of the mountain, passing Good's Gap and the new Neversink Mountain Hotel, the road winds along the south side of the mountain and reaches the summit, the elevation at this point above mean tide being 806 feet. This, the highest point along the road, is called Point Lookout, from which an uninterrupted bird's-eye view opens out before the observer of the Horse Shoe Bend and other windings of the Schuylkill River with its fertile valleys extending for many miles to the right and left.

From the summit, the road starts on its descent by easy grades and, crossing the ridge of the mountain to the north side, passes the Highland House, where the observer views the city of Reading below, with Mount Penn to the right and the Lebanon Valley to the left. After rounding the southwestern end the road again passes along the southern side of the mountain, below the summit, and through a series of sharp curves on a declivity extending from the summit to the river. A view of this characteristic portion of the road is shown in Fig. 2, from a photograph taken expressly for THE ELECTRICAL WORLD, from a point 150 feet above the tracks, and looking up the grade toward the northwest. The famous Klapperthal Ravine, with its park and pavilion, is crossed a short distance beyond, by a 30-foot trestle, a view of one of the cars standing on this trestle being shown in Fig. 3. The Klapperthal Pavilion, situated near the ravine, is a handsome structure 60 × 360 feet, accommodating 2,000 persons, and was erected by the P. & R. R. R. Co., in co-operation with the Neversink company, for their excursionists, and cost $20,000.

The road now winds down, passing the car house for this end of the line, reaching the Klapperthal terminal, where the P. & R. R. R. have recently erected their handsome Klapperthal station.

The "Short Line" is a portion of the road used on return trips. It extends from the Upper Junction, a point on the southern side of the mountain, to the Lower Junction, a short distance above the White House on the main line, as is shown on the map, Fig. 1.

This shunts the loop encircling the mountain over the summit, and shortens the usual trip by passengers changing cars at the Upper Junction if they so desire, and returning directly to the city, by way of the White House, instead of at first going to Klapperthal terminal.

The development of the Neversink Mountain as a summer resort was projected by the Klapperthal Land Company about ten years ago. This company improved the mountain, laid out carriage drives, put up an observatory, developed the water supply of Heiner's Mineral Spring, and allotted grounds for summer residences. The first project was not as much of a financial success as had been anticipated, so that the Neversink Mountain Railroad Company was formed to construct and operate an *electric* railroad over the mountain to make its points of interest more readily accessible. The successful operation of this road, due to the speed and carrying capacity of the cars, led to a completion of the original projects, laying out more drives and walks, and erecting a large excursion pavilion and the magnificent new hotel, which latter is under the management of the Neversink Mountain Hotel Company. In order to supply light and power to the hotels and pavilion and to light the parks, the Neversink Light, Heat and Power Company was organized for the required increased installation.

The route usually taken by the cars is from Ninth and Penn streets to the White House (Fig. 1), thence by the mountain loop over the summit down to Klapperthal Park and the terminal, a distance of 6.99 miles. On the return the cars go over the same route as far as the Upper Junction, thence down the Short Line, to the main line, at the Lower Junction, past the White House and down to Ninth and Penn streets, a distance of 4.07 miles, making the total length of the round trip 11.06 miles. The schedule time of the round trip is about one hour and 20 minutes, including all stops, though it can be made in one hour without difficulty. During the summer of 1891 the usual schedule for week days required a car to leave the terminus every half hour, necessitating three cars on the road, and for Sundays, every 20 minutes, requiring four cars or preferably five for heavy travel. The schedule and route are so arranged that about half the cars are going up grade while the others are going down grade. This arrangement makes a very economical distribution of power along the road; preventing, as far as possible, excessively large currents, such as would be required if all the cars were on up grade at the same time. The speed of the cars over the mountain is from 9 to 15 miles per hour.

The cars make from eight to ten trips a day usual running time, averaging from 88 to 111 miles per car per day.

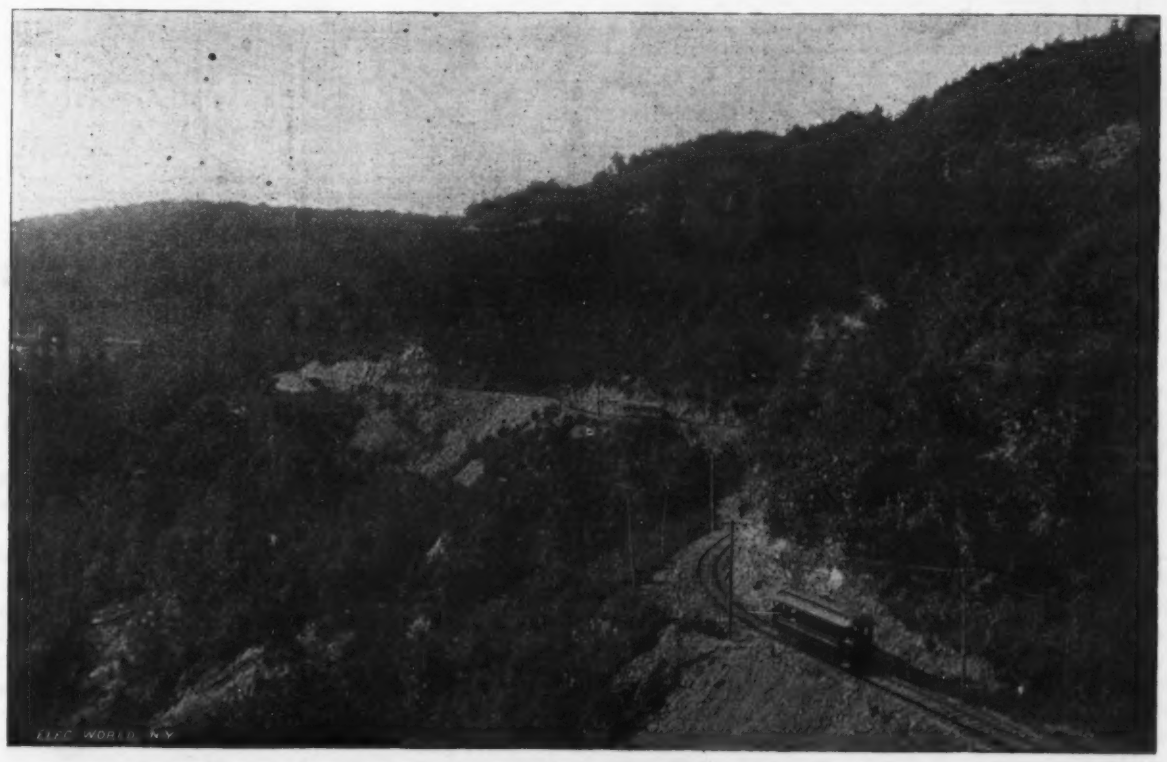


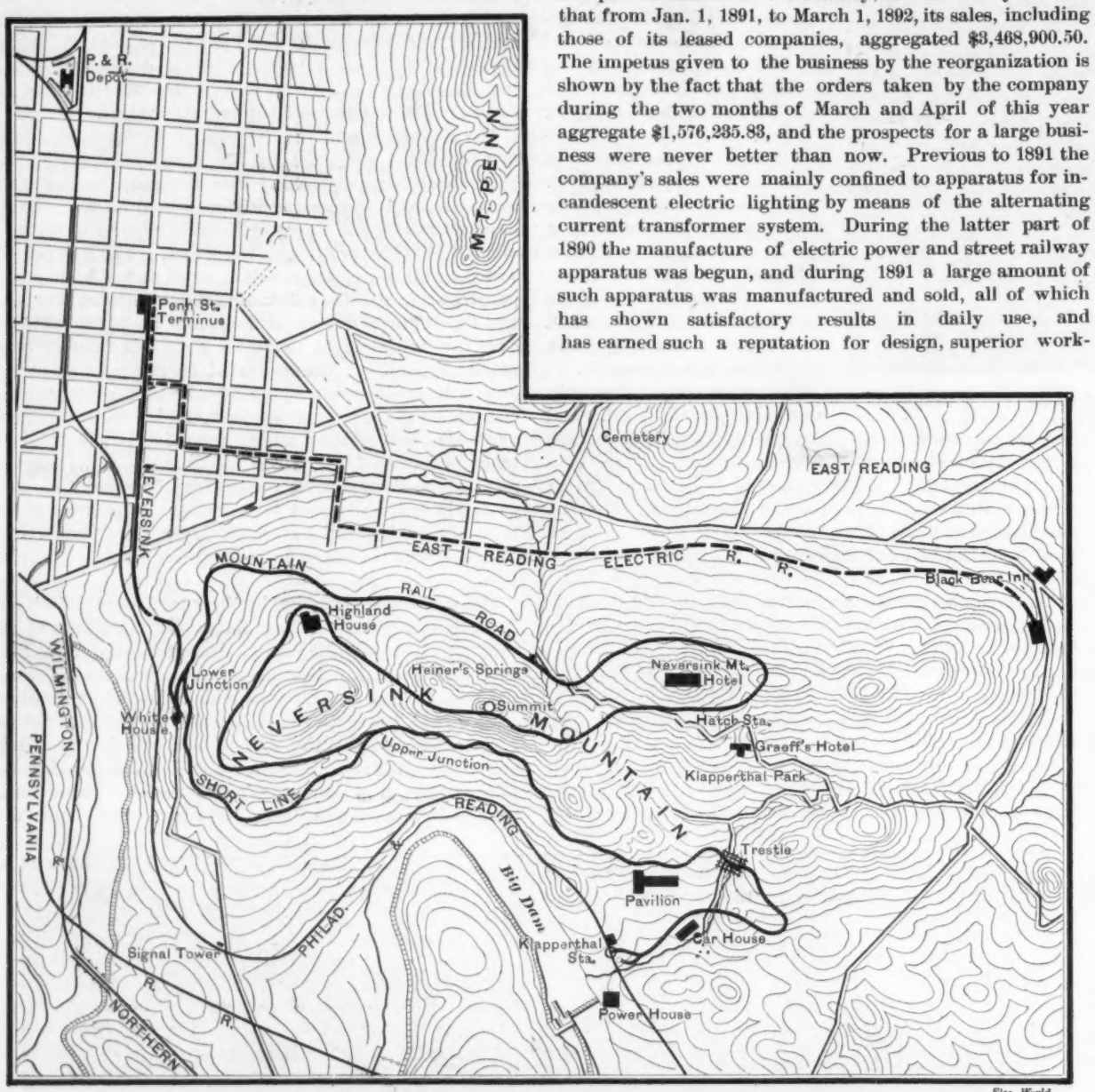
FIG. 2. VIEW OF NEVERSINK MOUNTAIN RAILROAD ON THE SOUTH SIDE OF THE MOUNTAIN.

The seating capacity of each car is 44 passengers, but in heavy travel they have carried as many as 170 passengers per car. During six weeks, in the summer of 1891, 40,000 passengers were carried, reaching a maximum of 3.000 per day with five cars on the road at one time. The company expects with its enlarged equipment to carry 250,000 passengers over the road during the summer months of 1892.

The successful operation of this electric railroad, mainly devoted to excursion business during the summer months, has led these companies to make several improvements in their road and develop many interesting features on the mountain; namely, to construct a new car house near the Ninth street terminal; to erect the large Neversink Mountain Hotel, 40 × 360 feet, at a cost of $100,000, to be opened the coming summer; to increase the rolling stock and road equipment; and to double the capacity of the power plant.

No accident of any kind had occurred to mar the success of this road up to the close of its second season, November, 1891, which speaks well for its excellent management.

Many capitalists from various sections have inspected the road with a view to adopting electric traction for mountain and other railroads in their localities. It is therefore



Elec. World

FIG. 1.—LOCATION OF THE NEVERSINK MOUNTAIN RAILROAD.

of timely interest to electric railroad engineers to place before them some of the technical features, details of construction and efficiency of operation of this pioneer electric mountain railroad.

Annual Meeting of the Westinghouse Electric Company.

The annual meeting of the stockholders of the Westinghouse Electric and Manufacturing Company was held in Pittsburgh on Wednesday, May 18. This was the first important meeting since the reorganization of the company. The meeting was called to order by Mr. Westinghouse, and the reports of the officials of the company were presented and accepted. The election for directors resulted in the selection of the old board with the exception of N. W. Bumstead, who succeeds Charles Fairchild, of Boston, as follows:

Charles Francis Adams, Lemuel Bannister, August Belmont, A. M. Byers, N. W. Bumstead, Marcellus Hartley, George W. Hebard, Henry B. Hyde, Brayton Ives, George Westinghouse, Jr.

The president, in his report, after commenting upon the organization of the company, stated as follows:

"Under the plan of reorganization the company has acquired (in addition to the shares previously held) all but 634 shares of the capital stock of the Consolidated Electric Light Company, paying therefor 75 per cent. of their par value in shares of the company at par, one-third in preferred stock and the balance in assented stock, thereby substantially relieving itself of the burden of fixed charges, amounting to some $250,000, incident to the leases of those companies. The following figures show the indebtedness of the company on Jan. 1, 1891, and March 31, 1892, and the reductions made between those dates in the indebtedness of the company and its leased companies:

Bills payable, Jan. 1, 1891, $3,076,021 11; March 31, 1892, $461,902.17. Reduction, $2,614,058.94.

Accounts payable, Jan. 1, 1891, $622,469.51; March 31, 1892, $223,973.19. Reduction, $455,496.32.

Sundry liabilities, Jan. 1, 1891, $344,179.51; March 31, 1892, none. Reduction, $344,179.51.

United States Electric Light Company bonds, Jan. 1, 1891, $750,000.00; March 31, 1892, $350,000.00. Reduction, $100,000.00.

Sawyer-Man Electric Company mortgage, Jan. 1, 1891, $210,000.00; March 31, 1892, $210,000.00.

Scrip dividend, Jan. 1, 1891, $195,962.00; March 31, 1892, $194,362.00. Reduction, $1,600.00.

Total, Jan. 1, 1892, $5,298,632.16; total, March 31, 1892, $1,883,297.36. Total reduction, $3,515,334.80.

Interest paid Jan. 1, 1891, to March 31, 1892, $135,356.64. Total amount paid, $3,650,691.54.

By receipts sale of preferred stock applied to above, $2,875,000.00. From earnings and collections, $775,691.44. Total, $3,650,691.54.

"Notwithstanding the serious disadvantages necessarily incident to the reorganization, the company succeeded during this period in keeping its factories in operation and conducting a large business. It has thus been able to maintain its position as a competitor for the electric light and power business of the country, as is shown by the fact that from Jan. 1, 1891, to March 1, 1892, its sales, including those of its leased companies, aggregated $3,468,900.50. The impetus given to the business by the reorganization is shown by the fact that the orders taken by the company during the two months of March and April of this year aggregate $1,576,235.83, and the prospects for a large business were never better than now. Previous to 1891 the company's sales were mainly confined to apparatus for incandescent electric lighting by means of the alternating current transformer system. During the latter part of 1890 the manufacture of electric power and street railway apparatus was begun, and during 1891 a large amount of such apparatus was manufactured and sold, all of which has shown satisfactory results in daily use, and has earned such a reputation for design, superior workmanship and efficiency, that we are justified in expecting that this branch of our business will assume still larger proportions in the future. The selling and general expenses have been so reduced that your company is now able to make good apparatus at prices considerably below those prevailing last year, with the result of greatly stimulating the demand for all kinds manufactured by it. The company now employs over sixteen hundred men, and its factories, which are now capable of caring for monthly sales of over $500,000, can, with a comparatively small expenditure for new tools, be increased to a capacity of over $750,000 per month. The cash on hand, accounts and bills receivable, manufactured product and material partly manufactured and in the storeroom of your company and its leased companies, and other items available as working capital, aggregated on March 31, 1882, $3,322,280.19. In addition to this, the company has in its treasury 7,355 shares of preferred stock, 19,242 shares of assenting stock, and $332,751.97 of first mortgage bonds of local light and power companies, upon all of which the company expects to realize as may be required from time to time by the needs of the business. The company is also the owner of a large amount of stocks of local electric light and power companies which are constantly appreciating in value. According to the reports of the various companies the aggregate value of all the electrical machinery and apparatus turned out during the year 1891 did not exceed $25,000,000. As before stated, the capacity of our factories, by a slight additional outlay, can be increased so as to manufacture fully 40 per cent. of all the electrical light and power apparatus required by the trade. The unusual attempts of competitors to interfere with the trade of your company by the issuance of circulars and by threatening customers with patent litigation and other annoyances are having, as a matter of fact, a beneficial effect upon your business in many respects. It seems to be the view of your principal customers that all users of electric light and power apparatus must soon recognize that an independent concern like your company is essential to their prosperity, and that such a concern, conducted on good business principles, should be supported, as failure to do so might lead to such a monopoly in the electric light and power business that consumers would be forced to purchase apparatus upon any terms that might be dictated."

The treasurer's balance sheet shows as follows:

BALANCE SHEET, MARCH 31, 1892.

Assets.

Cash in banks		$88,145.24
Bills receivable		224,238.72
Accounts receivable		1,247,427.50
Material in stock (at cost of labor and material)		509,543.82
Advances to leased companies		1,045,057.81
Stocks and bonds		4,003,163.09
Real estate and buildings		415,082.77
Machinery and tools		459,968.86
Miscellaneous		63,424.75
Charters, franchises, patents, etc		4,346,717.19
		$12,402,769.75

Liabilities.

Accounts payable		$253,956.38
Bills payable		455,462.17
Sundries, contracts and contingent liabilities:		
Scrip dividend due Sept., 1890		194,362.00
Stock subscription		35,075.00
U. S. E. Lighting Company, six per cent., 15 year bonds, 5),000 payable annually		650,000.00
Capital stock liabilities:		
Preferred stock, 72,384 shares	$3,619,253 00	
Assenting stock, 100,758 shares	5.027,916.00	
Common stock, 5,526 shares	276,300.00	
In treasury, 21,332 shares		
		8,933,469.00
Surplus		1,880,445.20
		$12,402,769.75

The reports were considered highly satisfactory, especially that portion where the indebtedness is shown to have been reduced from $5,398,632.16 in January last year to $1,833,297.36 in March last.

The Vacuum in Lamp Bulbs.

BY ADOLPH BERRENBERG.

One of the most interesting stages in the progress of the manufacture of incandescent lamps is the exhaustion of air from the bulbs by the mechanical air pump. Until recently all lamp manufacturers have made their lamps with the aid of mercurial pumps. But this is no longer true. The Beacon Vacuum Pump and Electrical Company, of Boston, manufacturing between 2,000 and 3,000 lamps per day, uses the Berrenberg metallic vacuum pump for the exhaustion of its lamps without the aid of mercurial pumps, and its lamps have a far better vacuum than any lamp that is exhausted by means of a mercurial pump.

In the mercurial pump the mercury is the piston and the glass tube the cylinder. Now I claim that a metallic piston can be made to fit the walls of a cylinder more closely than mercury will fit to glass. For instance, let a tube 36 or 40 inches in length be filled with the best distilled mercury, closed up at one end, and placed in a vertical position and connect a good vacuum pump on the opposite side. There will be at once seen thousands of little bubbles rising between the mercury and the walls of the tube, growing larger the nearer they come to the top. This experiment shows how close mercury clings to the wall of glass. A Torricellian vacuum can only be made by filling the tube with mercury and boiling the mercury in the tube. After boiling the tube is reversed and we have a Torricellian vacuum.

In 1885, when I first thought of making a metallic pump to be used for incandescent lamps, I looked over the whole field to find out what had been done in this line, but I found nothing except pumps that would remove 90 to 95 per cent. of the air. All these pumps have a soft piston packing consisting of either leather cups soaked in glycerine, or a hemp packing. Something had to be done to get a good piston, and a piston that would run for years without ever renewing the packing rings; something which would reduce expenses and delay in a pump of such fine workmanship. I therefore began work on a metallic piston packing. Two years of experimenting in this line produced an air tight piston and cylinder by which I was enabled to create a vacuum and to hold it for several days without any leakage whatever. Thus the problem of inventing a mechanical air pump was solved. The first pump was built, which produced a vacuum in 24 lamps in 15 minutes, but the lamps were of short life. At that time the inventor was not familiar with the gaseous filaments. The lamp-makers were more than pleased with the result, as the metallic vacuum pump for incandescent lamps had been predicted a failure by all those who had heard of it.

A second pump was built and constructed to be operated with mercury, but owing to the unforeseen action of mercury on metal in a vacuum, this pump did not work. The construction of the pump, however, was satisfactory, the only thing missing was a non-volatile liquid. With the assistance of a chemist this liquid was found, and the mechanical air pump became a success on the 9th day of May 1890.

Vacuums created by the Berrenberg pump are better than those made by the best of mercurial pumps. The pump in use by the Beacon Vacuum Pump and Electrical Company can exhaust 600 lamps at one time in less than an hour while a mercurial pump, of whatever style, cannot make as good a vacuum in five hours on six lamps.

Furthermore, the residuum or vapor of mercury in a globe exhausted by a mercury pump is injurious to the

filament. It will likewise blacken the interior walls of the globe, cutting off a portion of the light. On the other hand, a lamp exhausted with a metallic vacuum pump leaves as a remainder vapor of oil or hydrocarbon, which will be decomposed by the filament in about twenty-five hours, and thereafter such lamps have a perfect or a Torricellian vacuum. The result is that the lamp will not blacken because it cannot convey the small particles from the filament to the glass, and consequently it will give the normal candle power throughout the life of the lamp, which is also prolonged.

Glass pumps are limited in size, but mechanical pumps can be built to any size, even for the exhaustion of thousands of lamps at a time in from 10 to 15 minutes. At present it takes 20 minutes to get rid of the gases contained in the filament. A filament for a lamp that would not contain gases would be a profitable invention.

The First Elevated Electrical Railroad.

BY GUY B. WAITE, C. E.

The elevated cable railroad of the North Hudson Railroad Company, which connects the Christopher street ferry, Hoboken, with Jersey City Heights, was built in 1885. It is 1¼ miles long, extending westward from the ferry across the principal streets of Hoboken with a slight ascending grade (being a nearly uniform elevation above the pavements). Some 500 yards from where the road reaches the foot of the hill under Jersey City Heights it becomes suddenly steeper, being five per cent. grade, which continues uniformly to the top of the hill. At this point it suddenly drops before terminating in the power station.

Up to the present time all passengers arriving at the power station by this cable road were entitled to further transportation and were compelled to change to the surface horse cars. It was considered desirable to extend the present cable road from the power station southward through a portion of Jersey City to facilitate and solicit travel to and from that locality, giving direct communication between Hoboken and its ferries and Jersey City and its heights. The structural work for such an extension extending from the power station to within the vicinity of the Court House in Jersey City, a distance of one mile, was commenced some 18 months ago and has recently been completed.

The power station is centrally located for operating this extension in connection with the present cable road (the original designer provided for so doing), and this was the proposition while the structural part of the extension was in progress. Before equipping this part of the road with the cable, however, other systems of motive power were considered. In comparison with the cable, the advantages which an electrical road has of automatic regulation and speed, the safety, convenience and simplicity of its management, the cheapness of its construction and maintenance, together with economy in its operation, naturally led to its adoption. The contract for equipment has been let to the Thomson-Houston Electric Company for their trolley system.

Each of the six cars used on this mile of extension is furnished with two Thomson-Houston single reduction motors of 25 h. p. each and the usual electrical street car equipment.

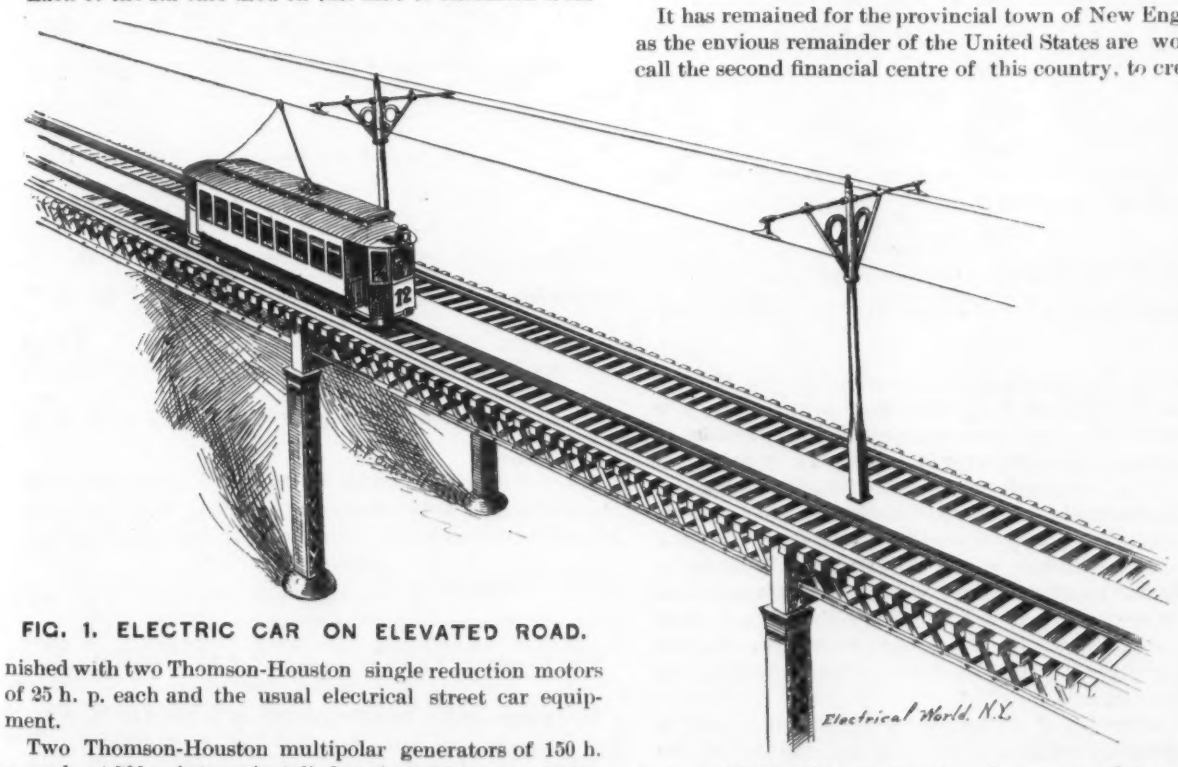


FIG. 1. ELECTRIC CAR ON ELEVATED ROAD.

Two Thomson-Houston multipolar generators of 150 h. p. each (at 500 volts) are installed at the cable power station for furnishing current for the motors, while a new Ball engine runs the generators, for all of which data I am indebted to Mr. Chas. B. Brush, chief engineer of the N. H. R. R. Co.

The construction of the electrical line on the elevated structure is so simple as to give but little encouragement to electrical engineering contractors. Fig. 1 shows a general view of the completed road with a single post between the tracks about every 100 feet, with a single feed wire on top, and having an arm with a trolley wire suspended from it projecting over each track.

Fig. 2 shows the attachment of the post to the structure A cast iron shoe is bolted to the lower flange of the girder in which the post rests, while a wrought iron strap, which is secured to the upper flange of the girder, embraces the post and holds it securely against the girder. The return wires are fastened to the wooden ties between the rails of each track and connected electrically to each rail in the usual manner.

Some novelties of this trolley line are: its independence from surface hindrances and their politics; it is a railroad in the popular sense running between definite stations; most of all, it is the introduction of the first elevated electrical railroad.

The cable road, which has been briefly described, has a difference in altitude between the ferry and the power station of 105 feet. The cars are gripped to the cable in both directions, so that no energy is lost in consequence of the grades.

The work done in running the cable is made up of that required for overcoming the resistance to its movement when running empty and the work done in moving the cars. If 50 h. p. be required to move the empty cable and 150 h. p. be required to move an average number of cars, the efficiency of the cable will be 66⅔ per cent. From the fact that the work required to move the empty cable is considerable and it is uniform whatever be the number of cars in operation, the efficiency becomes very small when but few cars are running. For this reason the cable is stopped during the early hours of the morning, dummy engines hauling the cars during this time. For advantages which the electrical system has over the present one it has been decided to change this cable road into an electrical road in the near future—as soon as the present cable shall have become disqualified. This, in connection with the new extension, will give a continuous electrical railroad from Christopher street ferry to the County Court House in Jersey City.

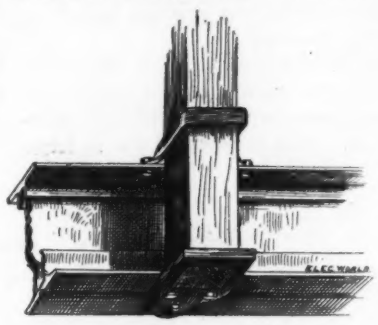
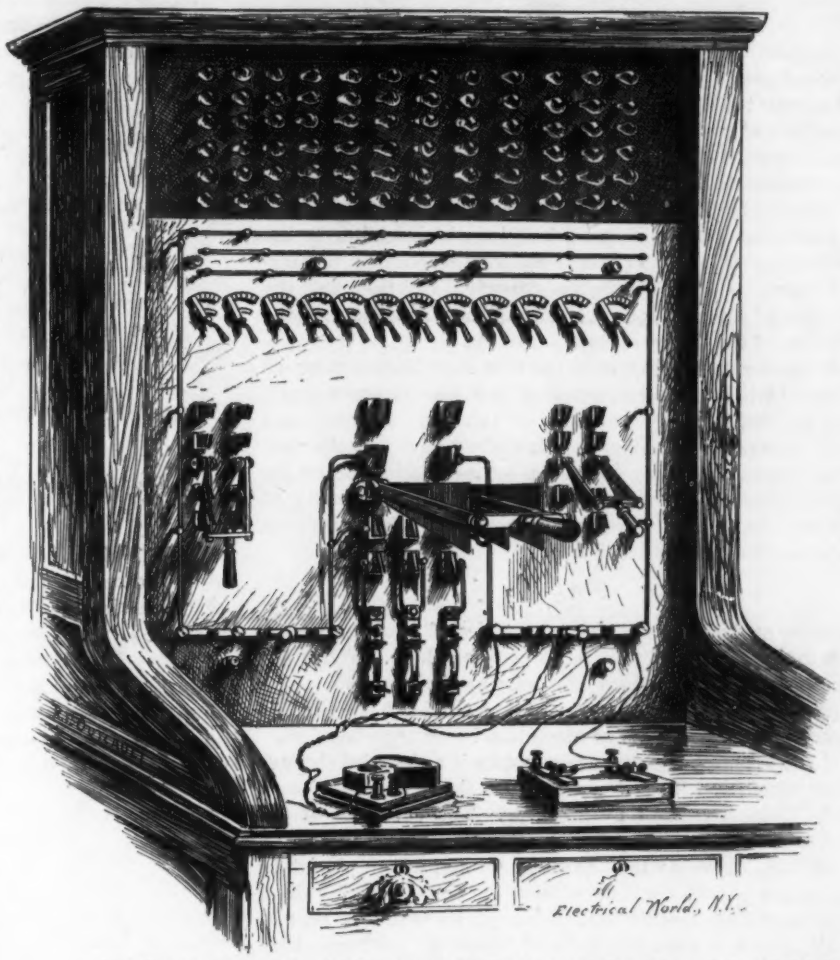


FIG. 2.—POLE SUPPORT.

Testing Board in the Department of the Inspection of Wires in the City of Boston.

It has remained for the provincial town of New England, as the envious remainder of the United States are wont to call the second financial centre of this country, to create a system of inspection of electric wires, a complete system that is at once the terror of cheap John contractors, the envy of insurance exchanges and the standing indictments of boards of electrical control that have made confusion worse confused in other cities. The power of inspectors of wires in Massachusetts is not mandatory. They cannot order any change in electrical apparatus and enforce their order by process of law. A simple report filed away as a city record and a notice that work is unsatisfactory has in every case brought about the most complete changes that a dilettanti electrical engineer could suggest. From the first the department has been under the charge of Capt. Brown S. Flanders, the head of the city fire-alarm service. After several changes on paper the department was merged with the fire department and under the control of the fire commissioners. The office of the inspection department has temporary quarters on School street opposite the City Hall. On the completion of a central building for the fire alarm, fire and inspection departments the present offices will be abandoned.

The proposed building will be a model one, and in it the quarters for the department of inspection of wires will be fitted with the most elaborate testing apparatus. Captain Flanders, from his long training in the fire-alarm service, realized from the first, perhaps as no one else could, the difficulty in organizing a new department with untrained assistants, and in the face of prejudice caused by years of incompetent and ill-advised inspection in other cities. The selection of an able force of assistants accomplished about a year ago, the work of inspection began. It was soon found that the cut-outs, switches, fuses and fuse-boxes in use were capable of doing a great deal more and sometimes a great deal less than was represented to be the case. Fuses particularly, so the inspectors declared, would bear more overloading beyond the rated capacity than anything else in the electrical or mechanical world. The "doctors" disagreed. To settle such disputes, and they came up daily, Captain Flanders designed and had constructed a testing board which for practical work leaves nothing to be desired. The arrangement is simplicity itself, nothing more than a bank of lamps that may be thrown in one at a time in series with instruments and fuses or other apparatus. The present differs from the crude attempts that are common in central stations for meter testing in the convenient arrangement of switches and binding posts. The lamps can be turned on one or more at a time, in such a way that the current can be increased half an ampère at a time. The board is arranged for the three-wire system. At present connections are made with the Edison underground by throwing the centre switch down and putting solid plugs in the holes above the safety fuses. By raising the centre switch to a horizontal position the board is entirely cut out of circuit. On throwing the switch into the upper terminal, connection would be made with the mains leading to an alternate current transformer. This part of the board is not now in use, but connections will be made for a supply of alternating current at the new building.



TESTING BOARD OF THE BOSTON INSPECTOR OF WIRES.

Current enters the board above the table, passes through large fuses, thence through plug switches to the lower terminals of the main switch. The two smaller switches to the right and left of the main switch throw the load of 72 lamps one half on each side of the system or all on either side. The current leaving the main switch either to the right or left traverses bars of copper at the lower part of the board. The circuit is made complete by plug switches between these bars. The binding posts on each bar are for connections with ammeters, voltmeters and apparatus to be tested On pulling the plug switches connecting the strips, current passes through the ammeter and fuse box or fuse wire under examination. The amount of current is regulated by the number of lamps in circuits. This is accomplished by moving the sliding switches twelve in number in the centre of the board.

The base of the switchboard proper is made of slate. The lamps are fastened to wood. A roll top covers the whol face of the board when not in use. The wires made by the Easton Electric Cable Company are run in conduits. The front is lighted by two incandescent lamps on brackets; the rear of the board can be examined by a movable lamp. Some very interesting tests have been already made by means of this board, and this work of Captain Flanders will make obsolete many of the favorite rough and ready

data and rules that have been the bane of electric lighting for years. For a long time opinion and guess work have guided the design, manufacture and the methods of installation of electrical apparatus. The Boston inspection department at least has the means to test under practical working conditions all apparatus before its use is approved. It is hoped that the annual report of the inspection department will include a report of tests made on this board.

The Elementary Principles Necessary to Establish the Equation of Electromotive Forces for a Circuit Containing Resistance and Capacity.—III.*

BY FREDERICK BEDELL AND ALBERT C. CREHORE.

In the first parts of this paper the fundamental principles necessary to lead up to the derivation of the equation of energy for circuits containing resistance and self-induction only were given; then followed the solution of this differential equation, which enabled us to ascertain the current flowing in the circuit at any time. Following a similar plan in the present paper, the purpose is to give the necessary fundamental principles which lead up to the derivation of the differential equation of energy for circuits containing resistance and capacity, and then find the solution of this differential equation, and from it derive the solution of the various particular cases.

Every one is familiar with the fact that bodies may be charged with electricity, and that two like charges repel, and two unlike charges attract one another. It was found from experiment by Coulomb that if we have two charges, each concentrated at a point, the force of attraction or repulsion between them varies directly with the product of the two charges and inversely as the square of the distance between the two points, that is,

$$F \propto \frac{q\,q'}{r^2},$$

where q and q' represent the quantities of the charges, r the distance and F the force between them. When the quantities considered have the same sign, the product $q\,q'$ is positive, and therefore a force of repulsion has a positive sign. Similarly a force of attraction has a negative sign.

If the distance between these points is unity, the charges being equal, and if the force between them is a unit force, each charge is called a *unit charge*. The definition of the electrostatic unit of quantity of electricity, in the C. G. S. system, is then: that quantity which, when placed at a distance of one centimetre from an equal quantity (in a medium whose specific inductive capacity is unity—that is, in air), repels it with the force of one dyne. Where these units are used, and the medium is air, the law of force may be written

$$F = \frac{q\,q'}{r^2}.$$

Where the medium is not air, the force is found to be less and equal to

$$F = \frac{q\,q'}{\kappa\,r^2}$$

where κ is called the *specific inductive capacity* of the medium.

Since there exists a force between two charges of electricity, if either is moved so as to change the distance between them, mechanical work is done. The work done in moving any body against a uniform force is equal to the product of the force and the distance through which the body is moved *against that force*. The force between the electrical charges q and q' is $\frac{q\,q'}{r^2}$. If they be moved in any direction whatsoever, so that the distance r between them is changed to $r + dr$, the work done in moving them is the product of the force $\frac{q\,q'}{r^2}$ and the change in the distance dr, since the force may be considered constant throughout the small distance dr. Therefore the work is

$$dW = \frac{q\,q'}{r^2}\,dr.$$

Suppose a charge q is situated at the point A (see Fig. 7), and a charge q' is moved from the point P_1 to P_2. The work done in moving the charge is

$$W = \int_{r_1}^{r_2} \frac{q\,q'}{r^2}\,dr = q'\left(\frac{1}{r_2} - \frac{1}{r_1}\right)$$

It is seen that the work done in moving a charge from one point to another is independent of the path by which it is moved, and simply depends on the initial and final distances between the charges q and q'. If the distance r_1 is infinite (meaning that the charge q' is carried from an infinite distance to a point at a distance r_2), the work done becomes simply

$$W = \frac{q\,q'}{r_2}$$

If q' is unity and a unit charge is moved, the work becomes

$$W = \frac{q}{r_2}.$$

It is seen that each point in the region surrounding an electric charge seems to possess a certain characteristic which determines the amount of work done in bringing a charge from infinity to that point. This characteristic of the point has been called its *potential*. The potential V at a point is therefore defined as the work done in moving a unit positive charge from an infinite distance to that point; hat is, $V = \frac{q}{r}$. This potential is positive when the work is positive; that is, when work is done, in moving the charge, by some agent external to the system.

The potential at a point due to a number of charges, each concentrated at a point, is the sum of the potentials at that point due to each charge independently; that is,

$$V = \sum \frac{q}{r}.$$

If there is a charge distributed upon any surface and dq is the charge upon an element of that surface, the potential at any point due to this charged surface is equal to the sum of the potentials due to each elemental charge; that is,

$$V = \int \frac{dq}{r}.$$

The potential of a charged body is directly proportional to its charge, that is $q \propto V$, or $q = C\,V$ where C is some constant; for, suppose a body possesses a unit charge and its potential is V; a second unit charge brought from infinity to the body doubles its original charge. The potential is then $2V$, for the potential is the work done in bringing a unit charge from infinity to the point, and the work in bringing a unit charge to a body with a quantity $2q$ is twice the work in bringing a unit charge to a body with a quantity q. We thus see that q is proportional to V, and is consequently equal to V multiplied by some constant, that is

$$q = C\,V. \qquad (1)$$

If a body is charged to a unit potential and the quantity is q,

$$q = C.$$

C is therefore defined as the quantity of electricity upon a body when at a unit potential. This is called the *capacity* of the conductor. The capacity depends upon the geometrical form of the conductor and the specific inductive capacity of the surrounding medium.

Suppose a body is charged with a quantity of electricity q, and is at a potential V. The work done in bringing a unit quantity of electricity from an infinite distance up to the body is V by definition. (This is provided q is so large

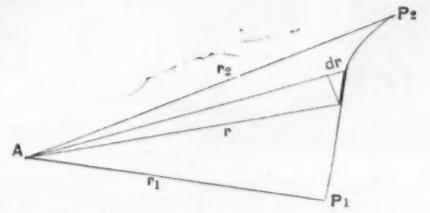


FIG. 7.—WORK DONE IN MOVING A CHARGED BODY.

in comparison with a unit quantity that its potential is not appreciably altered by the addition of the unit quantity.) If, under the same conditions, we bring up not a unit quantity, but a quantity dq, the work done is $V\,dq$, and this represents the increment of the energy of the charge q. That is

$$dW = V\,dq. \qquad (2)$$

Referring to equation (1), we may always replace V by its equal $\frac{q}{C}$, or dq by its equal $C\,dV$, and obtain the equations

$$dW = \frac{q\,dq}{C},$$

$$\text{and } dW = C\,V\,dV.$$

The integrals of these equations, taken between the limits zero and q, and zero and V, respectively, are:

$$W = \tfrac{1}{2}\frac{q^2}{C},$$

$$W = \tfrac{1}{2}\,C\,V^2.$$

Remembering that $q = C\,V$, each of these equations may be written,

$$W = \tfrac{1}{2}\,q\,V. \qquad (3)$$

Here W is the potential energy possessed by the charged body, as the limits of integration were taken from zero charge to charge q, and from zero potential to potential V.

A condenser is a device for increasing the capacity of a conductor by bringing it near another similar conductor, which is separated from it by any non-conducting medium or dielectric. This dielectric will be considered to be a perfect non-conductor; that is, the condenser is not *leaky*. A condenser usually consists of parallel plates separated by a distance very small as compared with the dimensions of the plates. When the condenser is charged, the two plates have equal quantities of electricity upon them, but of the opposite sign.

The total energy of a charged condenser may readily be found by taking the algebraic sum of the energies of the charge on each plate, as given by the equation (3).

If the plates of a condenser have charges $+\,q$ and $-\,q$ at potentials V_1 and V_2 respectively, the total energy is

$$W = \tfrac{1}{2}\,q\,V_1 - \tfrac{1}{2}\,q\,V_2 = \tfrac{1}{2}\,q\,(V_1 - V_2). \qquad (4)$$

That is, the energy of a charged condenser is equal to one-half the product of the charge of one of the plates and the difference of potential between the plates. If this difference of potential between the plates is simply V, the expression for the energy of a charged condenser is

$$W = \tfrac{1}{2}\,q\,V. \qquad (5)$$

The capacity C of a condenser is the quantity of electricity on one plate when there is a unit difference of potential between the plates, and when there is a difference of potential V the charge is

$$q = C\,V \qquad (6)$$

It can be shown that the capacity of a condenser, composed of parallel plates of equal area, whose distance apart is small as compared with the dimensions of the plates, is directly proportional to the area of the plates, and inversely proportional to the distance between them, and that the capacity is

$$C = \frac{A}{4\,\pi\,d}$$

where A is the area of and d the distance between the plates.

As the plates of a condenser approach nearer and nearer together, the capacity C becames larger and larger. In the limit, when the plates come into contact, the capacity becomes infinite, which means that, no matter how much one plate is charged, there can exist no difference of potential between them. If a circuit then has no condenser in it, but is a continuous conductor, it may be said to have a condenser of infinite capacity in series with it.

By combining equations (5) and (6) the energy of the charge of the condenser may be expressed in terms of the capacity and the potential V, or in terms of the capacity and the charge q. Thus,

$$W = \tfrac{1}{2}\,C\,V^2 = \tfrac{1}{2}\frac{q^2}{C}. \qquad (7)$$

The increment of the energy dW as the potential and charge vary simultaneously is,

$$dW = C\,V\,dV = \frac{q\,dq}{C}. \qquad (8)$$

To Find the Equation of Energy.—We can now write the equation of energy for an electric circuit having a resistance R, and having in series with that resistance a condenser of capacity C.

The total energy given to the circuit by the source of E. M. F. is $e\,i\,dt$. That part of the energy used in heating the conductor in the time dt is $R\,i^2\,dt$, as shown in a previous paper. The amount of energy required to change the charge of the condenser in the time dt is $\frac{dW}{dt}\,dt$.

Since, under the conditions supposed, these are the only two ways in which the energy imparted by the source is used, we have the equation of energy,

$$e\,i\,dt = R\,i^2\,dt + \frac{dW}{dt}\,dt. \qquad (9)$$

We have seen that $dW = \frac{q\,dq}{C}$ (equation 8), therefore,

$$e\,i\,dt = R\,i^2\,dt + \frac{q}{C}\,\frac{dq}{dt}\,dt. \qquad (10)$$

When a current i flows into a condenser for a time dt, the quantity which flows during this time is $i\,dt$, but this is the increment dq of the charge of the condenser, and

$$dq = i\,dt.$$

hence

$$q = \int i\,dt. \qquad (11)$$

Substituting these values of q and i in equation (10) we may write it in two forms, in terms of i or in terms of q, thus,

$$e\,i\,dt = R\,i^2\,dt + \frac{i\,dt\int i\,dt}{C} \qquad (12)$$

$$e\,\frac{dq}{dt}\,dt = R\left(\frac{dq}{dt}\right)^2 dt + \frac{q}{C}\,\frac{dq}{dt}\,dt \qquad (13)$$

Dividing (12) through by $i\,dt$ and (13) by its equal dq we have,

$$e = R\,i + \frac{\int i\,dt}{C} \qquad (14)$$

$$e = R\,\frac{dq}{dt} + \frac{q}{C} \qquad (15)$$

These are equations of electromotive forces where e is the impressed E. M. F. of the source, $R\,i$ or $R\,\frac{dq}{dt}$ the E. M. F. necessary to overcome the ohmic resistance, and $\frac{\int i\,dt}{C} = \frac{q}{C} = V$, the E. M. F. necessary to oppose the E. M. F. of the condenser.

When C is infinite, that is, as explained above, when the plates of the condenser come into contact, we have a circuit with resistance only, in which case equation (14) gives

$$e = R\,i,$$

which is Ohm's law.

*For the first and second sections of this article see THE ELECTRICAL WORLD, May 14, p. 331, and May 21, p. 349.

The Electric Railway as Applied to Steam Roads.

In a paper read before the American Society of Mechanical Engineers at San Francisco last week, Mr. B. J. Dashiell, Jr., described the experiments in high-speed railway work made by the Electro-Automatic Transit Company, at Laurel, Md., in 1889, a full description of which was given in THE ELECTRICAL WORLD of March 14, 1891. The tracks were of such light construction that the very high speeds attained could not be maintained. The conclusion was drawn, however, that the air resistance increased with the speed and not as its square, but this is somewhat dubious and must be supported by further evidence. Mr. Dashiell also gave a sketch of the electric locomotive built by the Thomson-Houston Company for the Whitinsville (Mass.) Machine Company, used for hauling freight cars from the company's works to the main line, a distance of one and a half miles. A description and illustration of this locomotive may be found in THE ELECTRICAL WORLD of Dec. 5, 1891.

Signatures of Some Prominent Foreign Electricians.

As a person's signature often expresses traits of his character, the following collection, made by one who enjoys the personal acquaintance of all these distinguished electricians, may be of interest to the readers of THE ELECTRICAL WORLD. These fac-similes were all made directly from the originals, none of which date back more than three years.

There can be no more fitting name to head such a list than that of Sir William Thomson, now known as Lord Kelvin.

Of scarcely less fame, and known chiefly for his early work with dynamos and cables, as also for his success as one of the founders of the largest and most successful electrical companies in Germany, is the venerable Dr. Werner von Siemens, whose presence and personal participation as presiding officer of the last International Congress, at Frankfort, was a pleasure to his numerous friends and admirers.

Among the others who were early workers in this field, and who are still active, are the two colleagues, Profs. E. Mascart and J. Joubert, of Paris, whose literary work is well known to many electricians.

Of more recently acquired fame in connection with his invention of the two-phase or rotary field alternating current motors, is the name of Prof. Galileo Ferraris, of Turin, whose modest and unassuming manners make it a pleasure to be acquainted with him.

His countryman, Prof. Antonio Róiti, is well known for his work on the determination of the ohm.

The original and important researches of Hertz, which have been widely printed, make his signature an interesting one.

Among the Englishmen whose names are familiar to Americans are D. E. Hughes, well known for his work with the microphone and the printing telegraph apparatus used so largely on the continent; W. H. Preece, who is at the head of the government telegraph department of England, and whose genial good humor has won for him many friends; Profs. W. E. Ayrton and John Perry, whose published works form a very important part of useful electrical literature; Dr. Silvanus P. Thompson, whose famous work on dynamos is known to every electrician; Prof. George Forbes, one of the few Englishmen who frequently visit America, appreciates what is good here, and returns to his countrymen to tell them things they do not like to hear about progress and enterprise in America; Messrs. W. M. Mordey and Gisbert Kapp, known chiefly for their creditable work in dynamo construction; John Hopkinson and Prof. J. A. Ewing, whose researches on the magnetic qualities of iron have become classic literature; Dr. J. A. Fleming, the leading writer on the theory of alternating current apparatus, and Oliver J. Lodge, whose theories of electricity have been read in every civilized country.

Among the French are Dr. G. Lippmann, of capillary galvanometer fame; Prof. Alfred Potier, whose modesty has perhaps prevented him from becoming as well known as his abilities would warrant; the late Emile Reynier, of storage battery fame; Gustave Trouvé, one of the most indefatigable workers with the primary battery for power purposes, and last but not least, the jovial and entertaining E. Hospitalier.

Among those in the more Eastern countries are the famous trio Carl Zipernowski, Max Déri, and Otto T. Bláthy, who are known chiefly for their early work with alternating current transmission and distribution.

Prof. H. F. Weber, although of Zurich, is a German; he was at the head of the commission which made the official tests of the Frankfort-Lauffen transmission, the results of which are awaited with great interest and impatience. Prof. Dr. W. Kohlrausch and Prof. Dr. E. Kittler are also among the Germans of national and international reputation, the latter being one of the first to start a regular course in electrical engineering at the University.

The venerable though still active Prof. Dr. A. von Waltenhofen is also one of the earliest professors of electrical engineering, having organized that department at the Vienna University in 1883, subsequently to the Electrical Exhibition in that city, which gave rise to the movement.

AUTOGRAPHS OF SOME PROMINENT FOREIGN ELECTRICIANS.

Dr. Alexandre Stoletow, professor at the University of Moscow, is one of the best known of the Russian electricians.

Among the youngest of the modern electrical engineers, though of no less fame than some of the older ones given above, are M. von Dolivo-Dobrowolsky, of Berlin, and C. E. L. Brown, of Zurich, to both of whom the success of the Frankfort-Lauffen transmission experiment was in a great measure due.

The Soldering of Aluminium.

A new method of soldering aluminium has been patented. The process consists simply of sprinkling the surfaces to be soldered with chloride of silver and then melting down the solder as usual. This method gives, it is said, excellent results, and will no doubt prove very useful on account of its simplicity.

Electro-Metallurgy.—IV.*

BY F. M. F. CAZIN.

As heretofore stated, all chemical reactions do result either in the production or in the absorption of free heat. The amount of free or thermable heat produced by the combination of metals with either oxygen, chlorine, sulphur, sulphuric acid or nitric acid is of great importance in electro-metallurgy, and, therefore, a list of these caloric or heat effects is given below.

Two different values for calories have been in use, namely, one called the "small calorie," representing the heat which raises the temperature of one gramme of water one degree centigrade. It is in small calories that the following table expresses caloric effects. But the same figures multiplied by 1,000 will express the heat effect, which raises the temperature one degree centigrade of one kilogramme of water; in other words, if the figures given in the table are made to express large calories they refer to kilogramme degrees, and if they are made to express small calories they refer to gramme degrees centigrade.

And in the same manner as the gramme of water is in the case of gram-calories the unit and as the kilogramme of water is the unit in case kilogramme-calories are used, so the gramme or kilogramme are the positive weight units in which the chemical equivalents of the matter entering the compound are assumed to have so entered in the reaction producing the heat as expressed in the table.

For electro-metallurgical purposes it is entirely irrelevant whether the one or the other be employed, because these caloric values are put to use, not for the purpose of calculating electric quantities, but only for calculating the quality of electrolytic action; this is the sufficiency or insufficiency in electric pressure (R) for the purpose of bringing about such specific electrolytic action as is under consideration, all of which will be plainly shown in the proper place.

CALORIC EFFECTS OF CHEMICAL REACTION IN FORMING THE COMPOUNDS AS NAMED AND RELATING TO GRAMME EQUIVALENTS WHEN SMALL CALORIES ARE EXPRESSED AND TO KILOGRAMME EQUIVALENTS WHEN LARGE CALORIES ARE EXPRESSED, AS ASCERTAINED BY EXPERIMENTING WITH SINGLE WEIGHT UNITS.

With O (15.96).	With Cl (35.37)	With S (31.98)	With SO_4 (95.42)	With NO_3 (61.89)
Ag_2O 5.9	$AgCl_2$ 9.3	Ag_2S 11.0	Ag_2So_4 167.2	$AgNO_3$ 28.7
Al^2O_3 388.6	$AlCl_3$ 237.7	Al_2S_3 124.4	.....	.....
As_2O_3 154.6	$AsCl_3$ 71.4	.....	.....	.....
.....	$AuCl$ 5.8	.....	.....	.....
Au_2O_3 — 13.2	$AuCl_3$ 27.2	.....	.....	.....
CuO 37.1	$CuCl$ 32.8	CuS 10.0	$CuSO_4$ 198.3	.....
Cu_2O 40.8	$CuCl_2$ 65.6	Cu_2S 20.2	.....	$Cu_2(NO_3)$ 82.2
FeO 68.2	$FeCl_2$ 99.9	FeS 23.7	$FeSo_4$ 235.6	$F_2(NO_3)$ 119.5
Fe_2O_3 191.7	$FeCl_3$ 127.7	FeS_2 35.5	$Fe_2(SO_4)_3$ 224.88	.....
HgO 30.6	$HgCl$ 41.2	HS 16.8	.....	$Hg_2(NO_3)$ 67.1
Hg_2O 42.2	$HgCl_2$ 63.1	.....	.....	$HgNO_3$ 38.9
H_2O 68.9	HCl 39.3	H_2S 9.2	H_2SO 210.7	HNO_3 49.1
K_2O 164.5	KCl 105.6	K_2S 113.2	K_2SO_4 344.5	KNO_3 119.3
Na_2O 155.2	$NaCl$ 97.6	Na_2S 103.9	Na_2SO_4 329.0	$NaNO_3$ 111.2
NiO 60.8	$NiCl_2$ 93.7	NiS 19.3	$NiSO_4$ 229.3	$Ni_2(NO_3)$ 113.2
PbO 54.9	$PbCl_2$ 82.7	PbS 19.0	$PbSo_4$ 216.2	$Pb(NO_3)_2$ 69.97
SnO 68.1	$SnCl_2$ 81.1	.....	.....	.....
SnO_2 133.5	.....	.....	.....	.....
ZnO 85.4	$ZnCl_2$ 112.8	ZnS 41.9	$ZnSO_4$ 248.4	$Z_2(NO_3)$ 132.3

The values quoted in the above table should not be confused with those calorie values relating to the combustion in oxygen, chlorine, etc., of single weight units of either metal or other relatively positive matter, such as C or even

* For the preceding section of this article see THE ELECTRICAL WORLD, May 14, 1892, p. 336.

CO to CO_2. But by dividing the calories expressed in the table by the chemical equivalents of the positive matter entering the compound, we can obtain the caloric effect of forming the compound with one weight unit of such positive matter. This, illustrated by the case of PbO, is as follows:

$$Ht = \frac{Ct}{+ Eqt} = \frac{54,902.0}{206.4} = 266 \text{ calories per weight unit of compound.}$$

Ht signifying the caloric effect of chemical unison to the compound, and relating to one weight unit of the compound.

Ct signifying the caloric effect of forming the compound of all equivalent matter entering the same, such equivalent relating to either grms. or kgms.

+ *Eqt* signifying the chemical equivalent of positive matter.

The reactions occurring in the Daniell cell may then be specified as follows:

(*a*) Zinc and sulphuric acid combine to sulphate of zinc (SO_4 Zn).

(*b*) Copper is precipitated out of a solution of sulphate of copper (SO_4 Cu).

It has been experimentally established that in the combination of sulphuric acid with any metal free heat is pro duced. In the two cases mentioned this heat has been found to be:

(1) When the following weights of matter stated combine

31.98 kilogrammes of S and
$4 \times 15.96 = 63.44$ kilogrammes of O

as 95.42 kilogrammes of SO_4
with 64.90 kilogrammes of Zn

to 160.32 kilogrammes of SO_4 Zn

248,430 kilogramme degrees or calories are produced.

(2) When the following weights of matter stated combine

95.42 kilogrammes of SO_4
with 63.20 kilogrammes of Cu

to 158.62 kilogrammes of SO_4 Cu

198,300 kilogramme degrees or calories are produced.

As in the Daniell element the SO_4 Zn is formed, while the SO Cu is disunited, the former reaction produces heat and the latter reaction absorbs heat, and in the production of 63.2 kilogrammes of Cu in the Daniell cell there is produced the equivalent energy of $248,400 - 198,300 = 50,130$ calories. This energy, however, does not take the form of heat, but it takes the form of galvano electricity, which, by agreement, represents an E. M. F. of 1.12 volts, assumedly = 1.12 ohms × 1 ampère.

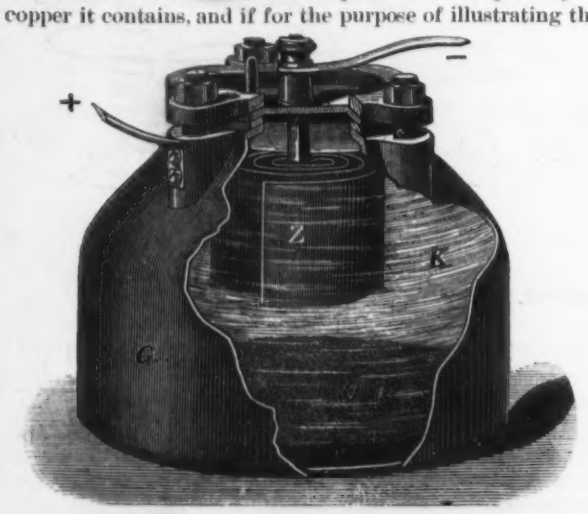
The electrolytic equivalent for the 50,130 calories, therefore, being 1.12 volts, *the caloric equivalent of the volt* is $= \frac{50,130}{1.12} = 44,759$ gramme-calories and relates to the deposition of 63.2 kilogrammes of copper.

A current (*C*) of one ampère precipitates (60 coulombs) per minute 19.85 milligrammes of copper, and (3,600 coulombs) one ampère per hour precipitates 119.1,

$$\text{or in } \frac{632,000}{19.85} = 31,840 \text{ minutes} = 5,306\tfrac{2}{3} \text{ hours,}$$

632,000 milligrammes = 63.2 kilogrammes of copper are precipitated.

The life of the Daniell cell depends on the quantity of copper it contains, and if for the purpose of illustrating the



Lalande Cell.

relations of quantity and time it may be assumed to contain 63.2 kilogrammes of copper and then it would live 5,306⅔ hours, or any other time proportionate to its copper contents.

But whatever the duration of its life may be, there is in every part or moment of such life an effect which is properly expressed either as the quality of its action, or as the equivalent to a permanent caloric effect, or as the electric pressure (*R*) required to produce the electrolytic effect in the named minimum quantity per ampère second.

Sufficient as the energy expressed by 50,130 calories may be for the action that is going on in the Daniell cell, it is not sufficient for the decomposition of other compounds requiring greater electric energy for their decomposition, such as SO_4 Fe, which, in being formed, produces a higher thermable caloric effect, and which, in consequence, demands a higher intensity, degree or pressure of electric energy as the cause of its decomposition.

The action of the cell demonstrates that its faculties are of two different kinds. Its faculty to precipitate copper at all depends on its possession of the precise amount of electric pressure required for such precipitation, or of the electric equivalent of 50,130 calories. Its faculty to precipitate such copper in quantity depends in the first instance on the time of its operation. But a multiplication of either action within the same time unit can be found only in the multiplication of given cells as such. And actual experience teaches us that to multiply any one of these two faculties a special and other method must be followed, than for multiplying the other of the two faculties possessed by the cell. This corresponds with the fact that the E. M. F. of the cell as expressed in volts as such represents a product of which only one factor can be multiplied at a time, and by special method, in order to multiply the total, and while such multiplication may by some operation be applied to either the one or the other, it can not in one and the same kind of operation be applied to both.

If *n* cells are arranged in series, the result appears comparatively as *n*, E. M. F. $= \frac{1 \text{ ampère}^2 \times n \text{ ohm}}{g} =$ $\frac{1 \text{ ampère} \times \text{volt } n}{g}$, but if they are arranged abreast (parallel) the result appears comparatively as

$$n \text{ E. M. F} = \frac{n \text{ ampères} \times \text{volt}}{g}.$$

Expressed in words, these facts should be stated as follows:

(*a*) Cells arranged in series (in a battery) multiply by their number the resistance (pressure head), leaving their current (area, quantity of action, ampères) as that of a single cell, such cells being equal to one another.

(*b*) Cells arranged abreast (parallel) (in a battery) multiply by their number the current (area or quantity of action, ampères), leaving the total resistance as that of a single cell.

(*c*) The distinction as to different cells depends on:

1. The nature of the chemical reaction and electrolytic disunion which takes place therein and by which the electric pressure (*R*) thereby given off (active, exciting cell) or consumed (passive cell or electrolytic bath) is measured uniformly for consecutive units of time under continuous conditions.

2. The quantity of electric current (*C*) depending on the face-quantity of electrodes in the exciting cell or cells.

In electroplating, where a comparatively small quantity of effect (metal) has to be spread over a large face (of cathodes), batteries are used, which are arranged with their cells abreast (parallel) of one another.

As the use of galvano-electric batteries is confined at this date almost exclusively to electroplating, and as no further opportunity will occur to describe single cells in their construction, it appears opportune to here describe the Lalande cell, which for such purpose deserves preference to all others, its principal merit consisting in its comparatively long life without being filled anew.

The Lalande cell consists of an iron bottle-shaped vessel (*G*), Fig. 2, having a diameter of 0.22 metre. When in use this vessel is hermetically closed by a hard rubber cover, between which and the top face of the vessel a soft rubber ring is inserted, and which is held down by three tap bolts and nuts. In the cover and near its circumference is inserted a small rubber valve, which is so arranged that gases under pressure may pass through it from the inside to the outside but not any air from the outside to the inside of the vessel. With open communication as between outside air and the contents of the vessel, the alkaline solution employed would deteriorate by absorbing CO_2 from the air.

Through the centre of the hard rubber cover passes a strong brass rod. It is held firmly in its vertical central position by a shoulder cut on it on the inside of the cover and by a draw nut on the outside, which presses a clamp to the outside of the cover and the shoulder of the brass rod o the inside of the cover. The brass rod holds on the i nside of the vessel at some elevation from its bottom a spiral of zinc sheet, both the brass rod and the zinc sheet being well covered with mercury (amalgamated). The positive conductor is attached to the iron vessel directly, its threaded end fitting into a threaded bore hole sunk into one of the bolt sockets. As the iron vessel itself is one of the poles, it must as a whole be insulated by an underlaid sheet of rubber cloth.

The cell must be filled first, with 0.9 kilogramme of cuprioxide (CuO), and second, with a solution of caustic soda or potash, consisting of 100 parts of water (by weight) and 40 parts of the alkali.

The E. M. F. of this cell is only 0.77 volt, therefore two such cells will be required to substitute one Bunsen cell. But the advantages otherwise connected with the use of the Lalande cell are so great, that the necessity of double their number does not outweigh them.

These advantages are:

1. No chemical reaction between electrolyte and electrodes takes place, when no current is made to pass between poles. This is, when they are disconnected and no plating work is being done.

2. The current of 8 to 10 ampères is constant, while one filling of the cell lasts a long while.

3. The life of the cell, when filled as hereabove stated, lasts in uniform action for 350 hours, requiring refilling only after acting for such number of hours, and as a consequence saving six times the work of renewal out of every seven, when compared with other cells.

4. No obnoxious gases are developed by the closed cell.

In ordinary plating practice six or eight of these cells arranged abreast are employed in a battery, their equally named poles being connected among themselves. (Compare, *L'Electricien*, t. vii., p. 433.)

The final and exclusively essential action of the Lalande cell consists in:

1. The oxygenation of zinc amalgam.

2. The disoxygenation of cuprioxide (CuO).

According to the preceding table of heat produced in the chemical reactions, by which the stated compounds are formed, the following values properly represent the reactions in the Lalande cell:

ZnO + 85,439 calories per equivalent in kilogrammes.
HgO + 30,660
+ 116,099
$2Cu_2O$ — 81,620
+ 34,479 as the caloric equivalent of electric energy produced. If, as shown above, 44,759 calories are the equivalent for one volt, then this electric energy of the Lalande cell has the value

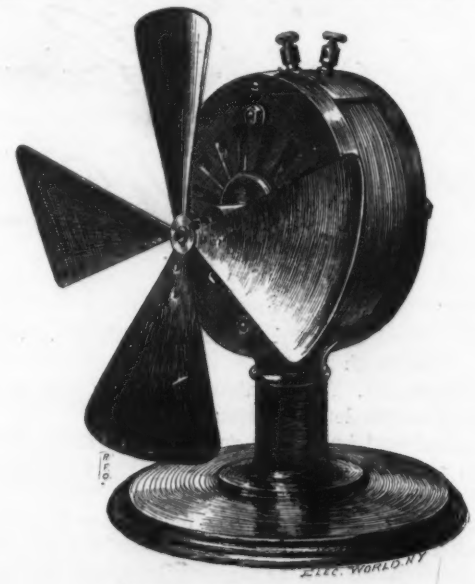
$$\frac{34,479}{44,759} = 0.77 \text{ volt.}$$

The Gutmann Alternating Current Fan Motor.

So far alternating current fan motors have been more trouble than benefit to central stations, because the efficiency, especially of small motors, is very low; but besides this trouble was frequently due to the mechanical construction. On account of the small torque developed by such fan motors, the brush contact had to be of a delicate nature and adjustment, leading to constant trouble and requiring continual attention. The object of the present device is to overcome this chief source of trouble.

It is an induction motor, that is, a motor in which only the field winding is in circuit with the transformer, while the armature has no electrical connection with it. The motor can readily be attached to any lamp socket of a 50 or 52, 100 or 104 volt circuit. The armature is of the drum type and revolves in a bi-polar field.

On the commutator connected to the winding rests a single brush of special design. The peculiar form of brush adopted is a modification of the brush patented by Mr. Gutmann, on which a low resistance conductor is located between two conductors of higher resistance. The principle of this modified brush forms part of another pending motor case in the Patent Office shortly expected to issue; the modification consists in having a good current collecter and a high resistance conductor located on but one side, viz., that side where the segments leave the brush, so as to get rid of sparking. The brush is of a horseshoe form, subdivided and supported by an arm or bolt above the commutator. About half way between the support of the brush and its end are two internal projections making contact with the commutator segments, while in the direction of rotation the resistance of the circuit is increased by carbon blocks supported by the projections. To insure proper contact at all times the horseshoe brush is divided into two parts hinged on the support. At the opposite side of the commutator in respect to the support, a tension spring is applied to securely hold the brush projections on the commutator. It will be noticed that the brush has but one position, and as long as there is anything left of the brush it is bound to make contact with the commutator. It is therefore evident that an occasional glance at the motor, say once in two months, or once a month, is sufficient, but even this is not at all essential. It will be noticed that the brush is of a novel character as to its design and method of support, being intended to operate by gravity only. However, to reduce inspection and keep the commutator in good condition it has been considered advisable to add the tension springs. For larger motors running at slower speeds the gravity brush pure and simple will be used. On account of the small amount of trouble caused by the brush it has been encased so as to be out of the way. The bearings are of the self oiling type.



Gutmann Fan Motor.

Efficiency of Transformers.—I.

BY M. V. DOLIVO-DOBROWOLSKY.*

The developments, at the present time, of the transmission and distribution of power by alternating currents, and particularly by means of multiphase and high tension currents, has gained for itself a very prominent place. This development has made it all the more important to pay particular attention to the construction of the transformers. I do not wish to say that there has been too little written on transformers, or that too little experimenting has been carried on with them. On the contrary one could find many researches that have been made upon the effect of Foucault currents, and there are very complete studies of whether the hysteresis, in spite of the constant magnetism, does not change somewhat with different loads on the transformers, etc. But how to proportion this apparatus in order that it may work as economically as possible, what standpoint the constructing engineer should take when he wishes to design relatively practical and durable forms of efficient transformers, about this one will find exceedingly little in electrical literature. In discussing this subject there will be found many totally false principles, ideas and prejudices which are handed down from the past and are difficult to eradicate.

I am decidedly not, as the gentlemen present will see, an advocate of all of Mr. Swinburne's conclusions, but I must, in order to be just, give Mr. Swinburne the credit of having led the way to the practical treatment of the subject of transformers.

In my present paper I am unable of course to give a complete theory of the rational construction of transformers, as I picture the same to myself; I must limit myself to taking out, so to speak, only a single chapter from the same, and give you a view of the methods of looking at the problem.

In a paper which I read at the International Congress at Frankfort† I described briefly my fundamental law of the alternating current. I said: *The magnetism* (that is, the number of lines of force) *will always become so high that the electromotive force generated by the same in the apparatus and added to the loss of potential becomes equal to the ap-*

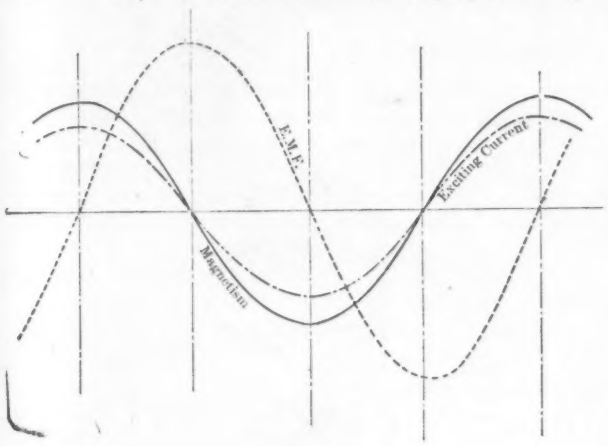


FIG. 1.

plied electromotive force. If N is the number of lines of force, p the frequency, w the number of windings of the coil and E the so-called electromotive force, the following well known relation will exist:

$$E\,10^8 = 4\,p\,w\,N\,\ddagger$$

If now, in the first place, the loss of potential is very small, as is the case with transformers and motors; secondly, if the number of turns is given; thirdly, if the apparatus is complete—that is, if the number of turns is invariable, then the law given above simplifies itself to the following: *The magnetism is equal to the difference of potential at the poles multiplied with a constant factor.* In other words, the voltage is a measure of the magnetism, and vice versa.

This statement is a universal one without regard to whether the coil generates current or receives it, whether this current is strong or weak (the latter is naturally correct only when the loss of potential is negligibly small); whether, furthermore, the magnetism is received from the exciting source, or whether it must be partially or totally generated by the current which flows through the coil. The magnitude of the magnetic resistance has furthermore no effect. With the same number of windings or frequency, the magnetism is always the same for any particular voltage, and one might say that the magnetism and the voltage always balance each other mutually. In this manner of treating the subject all differences between induction, self-induction, mutual induction, etc., are done away with.

As the electromotive force at every moment is proportional to the rapidity of the change of the number of lines of force, and as the latter is largest at the moment of the change of polarity (see Fig. 1), the following important law results, namely, that the phase of the electromotive force or difference of potential differs by a quarter of a period from the phase of the magnetism.

As long as the current acts exclusively to generate magnetism or has merely to generate ampère windings, without doing other work, one cannot conceive of it otherwise as together with all its lines of force; in that case the phase of the current will coincide with the phase of the magnetism. By examining the diagram, Fig. 1, we will see that the current flows half of the time with the electromotive force and half the time against the same. During half the time, therefore, the coil is an apparatus consuming energy. A mean, therefore, shows that the current neither consumes nor delivers energy, that is, it is a "wattless" current. Such a wattless current, as it serves only to produce a magnetic field without delivering work, we will call the "exciting current."

When, however, a current is led into a non-magnetic apparatus, that is, when only resistance is to be overcome, and a magnetic field is neither present nor is generated, heat will be produced during the whole time, according to Joule's law; the current, then, pulsates synchronously

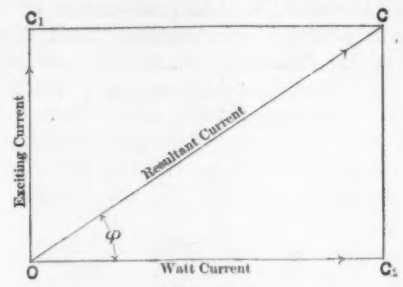


FIG. 2.

with the difference of potential at the terminals. This is the true "watt current." Neither the watt current nor the exciting current exist separately as such; on the contrary, the two are always combined together, as every current develops a magnetic field, and there are neither inductionless resistances nor coils without resistance, nor has there yet been discovered an ideal soft iron which has no remanent magnetism. Every alternating current, therefore, consists practically of two currents—of the watt current and of the exciting current—which must be added together as two forces at right angles to each other are, giving a resultant force. Fig. 2 shows the addition of an exciting current $O\ C_1$ with a watt current $O\ C_2$; from this $O\ C$ is the practical resulting current. The angle φ will then be the difference of phase of the resulting current and the applied difference of potential at the terminals, that is to say, of the electromotive force.

With high voltages or with very great periodicity the electrostatic capacity, that is, the electrostatic field, cannot be neglected. In that case there will likewise be a wattless current, a so-called "charging current," only that in this case the difference of potential at the terminals will lag behind the current by a quarter of a phase, or what is practically the same thing, there will be a hastening of the phase of the current by one-quarter of a period in reference to the difference of potential at the terminals. Strictly speaking, therefore, every alternating current will be the resultant of three currents; the exciting current, the generating current and the watt current.

In our present treatment of the subject of transformers we will neglect the factor of capacity, as it plays an important part only in special cases. From the fundamental principle given above many deductions follow for transformers, of which I will give the following as illustrations:

1. The magnetism of a transformer remains almost completely constant for all loads; it diminishes only in the same proportion as the loss of potential in the primary coils (the exciting coils) increases, that is to say, only by a few per cent. (from one to three). From this, furthermore, it follows that the hysteresis, the energy of the reversal of the magnetism in the iron core, has nearly a constant value; but this does not play an important part in the consideration of the size and efficiency of transformers, as it is practically of no importance whether one assumes that the transformer, on open circuit, consumes 2.00 or 2.02 per cent. of the full load.

2. With transformers on open circuit the watt current is quite small, as only the reversal of the magnetism in the iron and the minimum loss of potential in the copper represent a consumption of energy.

3. The current of a transformer on open circuit is com-

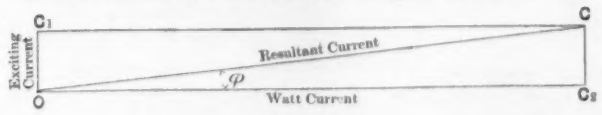


FIG. 3.

posed chiefly of the wattless exciting current, and is, therefore, dependent on the magnetic resistance. The magnetic resistance of the iron requires a more or less number of ampère windings for generating the magnetism required by the difference of potential. The given or assumed windings will then give the maximum ordinate of the exciting current.

4. If one constructs for a transformer the diagram shown in Fig. 2 one will find, owing to the small watt current, that the exciting current causes a very material difference of phase of the resulting current. This shifting of the phase, as also the strength of the resulting current, is greater the greater the proportion of the magnetic resistance (that is, the required ampère turns) to the primary number of windings. With transformers having many windings per unit of difference of potential, that is, with much copper, for other reasons, as will be shown later, the exciting current is for the reasons given above small, even when one does not consider the small magnetic resistance.

5. If a transformer is loaded, say with incandescent lamps or other practically non-magnetic resistances, only that component of the current which I called a watt current will increase, and the difference of phases will therefore be diminished. Fig. 3 shows that even when the current required for the exciter is 10 per cent. of the maximum working current we will have practically no difference between the resulting and the watt current, or between the apparent and true watts, during full load. The angle δ is in this case only six degrees, the cosine of which is .985, and therefore the true current differs from that calculated from the watts by only 1½ per cent. With most transformers the exciting current is far below ten per cent., and therefore with incandescent lamp distribution it is not at all necessary to take cognizance of the shifting of the phase in the transformer.

6. When, as with transformers having an open magnetic circuit, the exciting current is large in proportion to the cross-section of the copper, the loss, according to Joule's law, cannot be neglected on open circuit; it represents a larger component of the watt current than could be caused by hysteresis alone. This is the case, for instance, with the Swinburne hedgehog transformer, in which the exciting current is about 30 per cent. of the maximum watt current; notwithstanding this, the consumption of watts on open circuit is said to be only about one per cent. of the total output.

7. If the load on the transformer consists of coils or similar magnetic apparatus, it will have to deliver chiefly an exciting current. The result of this is, that in that case also primarily only the exciting current increases and that a diminution of the shifting of the phase does not take place. In all cases the diagram in Fig. 2 will hold good, and the transformer connected between the generating stations and the place of consumption will add only its own exciting current and its own watt current required for losses in it.

8. By increasing the magnetic resistance of transformers, as, for instance, by inserting paper between the junctions of the iron parts (see Fig. 4), one can increase the exciting current in order to compensate for the reverse shifting of phases due to the electrostatic capacity of the line. By this

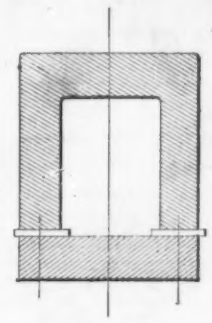


FIG. 4.

means the current to be generated by the dynamo may be made relatively a minimum in comparison with the consumption of watts.

Having now given you, by means of the above illustrations, the electrical theory of transformers corresponding to this new way of treating the subject, I will pass over to the question of dimensions. To give a uniform receipt or rule for the best calculation of transformers is as impossible as it would be for dynamos. As in the latter case, the best method is to sketch on paper a number of transformers, to calculate them, and then to make a choice of the one best suited for the particular case in question.

If one considers at the start certain guides, one can, after some practice, acquire a certain "feeling," enabling one to find the desired dimensions quickly and without wasting too much paper. Curves will also be of great value when one designs an intermediate form of transformers between two given sizes.

After a transformer is sketched, one applies to it the following important test calculations: At first it is necessary to see that the copper resistances are sufficiently small, which is a very simple matter. Then, if no changes of size of the copper cross-section are necessary, calculate the energy consumed in changing the polarity of the iron. One of the most difficult problems in the construction of transformers is to have a small loss of energy in the iron, at the same time leaving sufficient room for the windings.

The energy of alternating the magnetism depends largely on what is now called hysteresis, but one must also add to the hysteresis the Foucault currents, which are never totally absent. The influence of the latter is, however, very small, by subdividing the iron in the rational manner. I have at least often noticed this in examining the curves of the total energy consumed in the changing of the magnetism at different magnetic densities and frequencies. The loss of watts due to hysteresis is for a given magnetic density simply proportional to the volume of iron and also nearly proportional to the frequency (a very small increase is caused by the Foucault currents).

Concerning the dependence of the iron losses on the intensity of magnetism I have found almost always a very close agreement with the law given by Mr. Steinmetz, namely, the 1.6 power, also with the curves of Prof. Ewing. I would here call attention to the fact that the numerical factors must be taken differently and that they change with the quality of the iron. From very many samples of sheet

* Paper read before the Elektrotechnischer Verein, Berlin. Translated for THE ELECTRICAL WORLD.

† See THE ELECTRICAL WORLD, Oct. 10, 1891, p. 268.

‡ The effective electromotive force is, as is well known, about 10 per cent. higher than this mean.

iron tested in the Allgemeine Elektricitäts-Gesellschaft during the past two years, I found some whose value was 1.2 to 2.5 times larger than those of Prof. Ewing. I believe that for the average practice the Ewing figures should be multiplied by 1.6 to 1.7. The curve in Fig. 5 shows us the losses per 100 kilogrammes of a medium good iron at 80 changes of polarity, that is, at 40 periods and at different magnetic in-

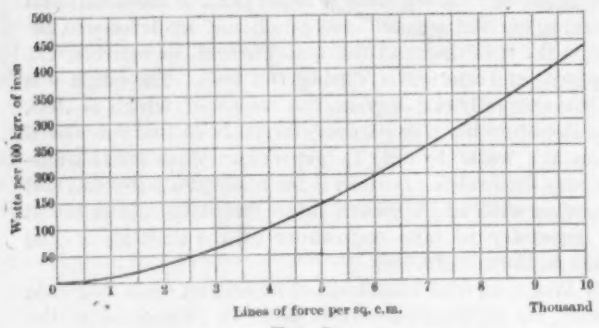


Fig. 5.

tensities. The figures represented by this curve are about 1.7 larger than those of Ewing. For frequencies which are not altogether too far from the above figures, one can safely assume proportionality.

One of the chief features of the transformer is undeniably a high efficiency. But with transformers which are used in distributing stations or in central stations, the efficiency has to be defined differently than we are accustomed to define it for dynamos and motors.

The loss taking place in transformers must be distributed over the whole day, that is to say, over 24 hours, during which time they are fully loaded for only a relatively short time, and that only in the winter. By the true or average efficiency of the transformer we should therefore mean the ratio of the daily useful output to the watt hours which have been delivered to the transformers. Naturally, the

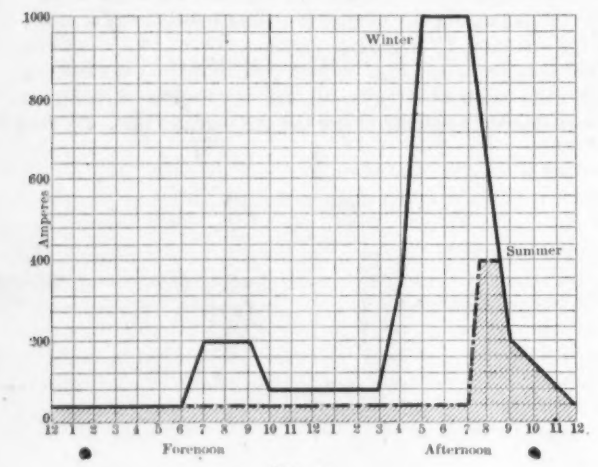


Fig. 6.

efficiency will in this case become dependent on the curve of the delivered current during the whole day, for which, if unfavorable, the manufacturer is not to blame. But it is, nevertheless, possible to approximately draw a mean daily consumption curve for particular districts in a city, and from this determine approximately the all-day efficiency of the transformers, and to use this as a guide in their construction. Figs. 6 and 7 give, for instance, the current consumption at the Berlin Elektricitäts Werke and of an average city of Germany, in the latter of which there were no motors running during the day. By examining these curves we see that the efficiency of transformers at maximum load has scarcely a perceptible influence on the average economy, and that one should consider chiefly the losses at light loads.

The losses in transformers are of two kinds, first, those which are determined by the resistance of the copper, that

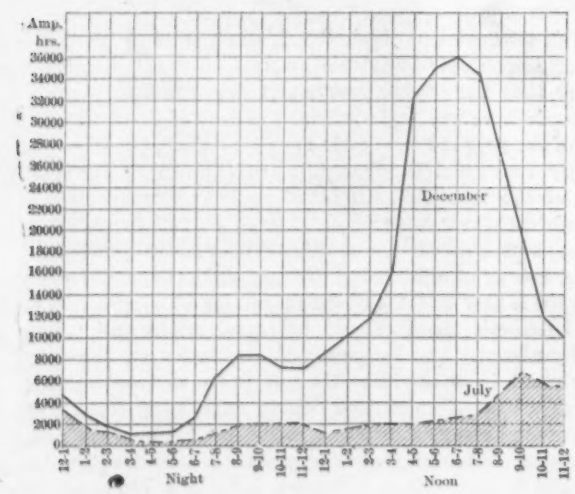


Fig. 7.

is, simply "copper losses;" second, the losses in the iron, which, as stated above, are chiefly due to hysteresis. We will designate them simply as "iron losses." The copper losses increase with the square of the current; if the exciting current in the transformers is small, as is mostly the case, we can assume approximate proportionality between current and load. It follows then simply that the copper losses increase and decrease with the square of the load. If, for instance, the copper losses at full load are 100 watts it will be only 25 watts for half the load and for .1 of the maximum only one watt. The copper losses have therefore little influence on the average economy of the transformer, in which only small loads are to be considered. But the iron losses are constant for the total range of the output of the transformer, on account of the constancy of the magnetism, as described above. They therefore play a relatively greater part the smaller the load is, and *vice versa*. In order, therefore, to have a high average all-day efficiency it is of importance to make the iron losses small.

A transformer can always be represented diagrammatically, as shown in Fig. 8, by two rings interlocked, one of copper and the other of iron. One cannot increase the cross-section of either of these rings without also increasing the other. The annoying feature with transformers is therefore that one cannot increase the cross-section of the copper (and therefore diminish the resistance and the copper losses) without correspondingly increasing the amount of iron and thereby increasing the iron losses. But it follows from this that as the copper losses affect the average efficiency only a little, one can, by allowing a relatively high copper loss, diminish the loss of iron, and therefore obtain a higher all-day efficiency. The objections to great copper

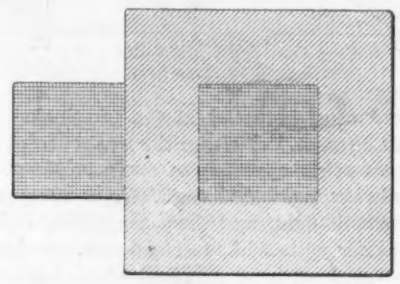


Fig. 8.

losses are only that in central stations the potential must be made slightly higher for greater loads. This would be a disadvantage were it not for the fact that in all systems of electrical distribution we are accustomed to this. In the feeders of direct current stations we do not hesitate to go as high as 20 per cent. above the required difference of potential. Even with alternating currents of high voltage it is seldom that the feeders consume less than two to three per cent.; adding to the latter a loss of two per cent., as is the case with most transformers, it gives a total loss of voltage of at least five per cent.

This five per cent. must, as at present, be compensated for by some means of regulation. Why should we not therefore with alternating currents regulate just as easily for seven, eight and even ten per cent. losses? Even this is still less than with direct currents, and a regulation of some sort must, in any case, be provided for. The idea of its being sufficient to keep the voltage constant at the station for an alternating current distribution has long ago been abandoned. I therefore propose to deviate from the traditional custom of allowing two per cent. loss in the transformer and to assume four or five per cent. as normal, particularly in cases where we cannot take the maximum, but must use the average all-day efficiency. We would save by this means more coal than we would at first suppose.

(To be continued.)

A Photometric Study of Electric Lights.*

BY NELSON H. GENUNG, B. S.

In a complete study of the sources of artificial illumination, quality as well as quantity must be considered. A photometer which will supplant the spectro-photometer as commonly employed, with all its long and tiresome processes, one which will enable the observer to explore the visible spectrum both rapidly and accurately, will doubtless prove a useful addition to every photometer room. The "horizontal slit" photometer, recently designed by Dr. Nichols to meet these demands, has greatly facilitated work in this department of physics.

This instrument consists of a direct vision spectroscope

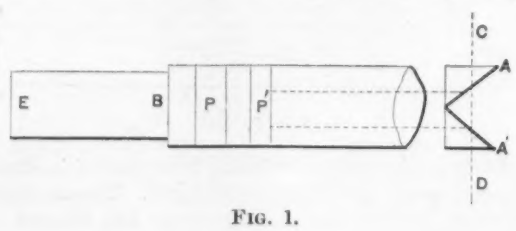


Fig. 1.

(Figs. 1 and 2), with a horizontal slit. Immediately in front of the slit are two totally reflecting prisms *A*, *A'*. The light from the direction *C* is reflected through the slit and the dispersing prisms *P*,*P'*, producing a vertical spectrum viewed by means of the eyepiece *E*. Similarly the light from the direction *D* is reflected by the prism *A'* into the slit and a spectrum is produced parallel to the spectrum from the direction *C*. The eyepiece is furnished with a horizontal cross-wire and a diaphragm with a narrow, rectangular opening through which corresponding portions of the two spectra may be simultaneously seen. The eyepiece with the first joint of the telescope is movable about *B*, the centre of a graduated semi-circle. This whole arrangement is mounted on a car so as to work the same as the ordinary Bunsen photometer.*

On increasing the candle-power of an incandescent lamp from 4 to 28 candles, the brightness of the spectrum near the *A* line increases in the ratio of 1:3.7; while the corresponding increase in the neighborhood of the *G* line is 1:22. It has previously been noted that at a certain point in the spectrum, approximately $\lambda = 600$, the ratio of the increase in brightness is identical with that of the increase

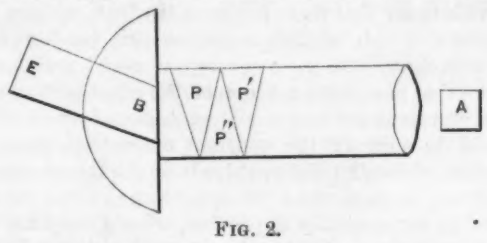


Fig. 2.

in candle power as indicated by the Bunsen photometer. The vertical line (Fig. 3) indicates this region.

M. Crova, in a recent communication to the Electrical Congress at Paris, recommended that on a light differing widely in temperature from that of the standard, the arc light in particular, the wave length $\lambda = 582$ be employed. As yet this wave length has not been satisfactorily established. When once permanently settled upon, photometry will be reduced to a comparison of intensities from the two sources of this particular wave length, and thus much of the personal error will be eliminated. But we can plainly see that any personal error, whether due to the Bunsen photometer or to the "horizontal slit" photometer, or both, will shift the position of the crossing point. It, therefore, seems necessary that each observer establish definitely the wave length of this region before he can employ this method of photometric study. The term crossing point will here be used as indicating the wave length which, in the "horizontal slit" photometer, gives the same candle power reading as does the Bunsen photometer.

1. THE INCANDESCENT LAMP.

A set of observations taken by the writer on an incan-

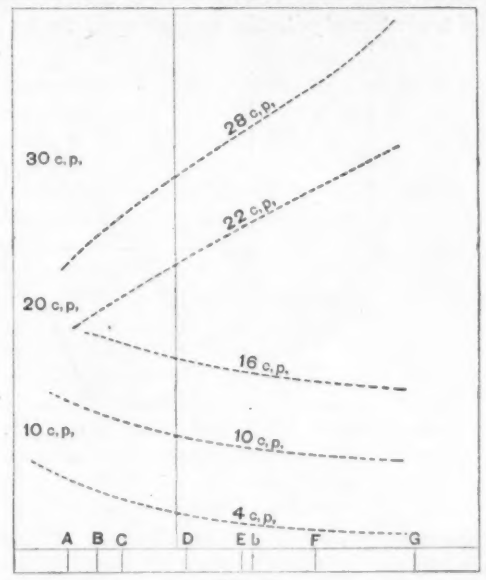
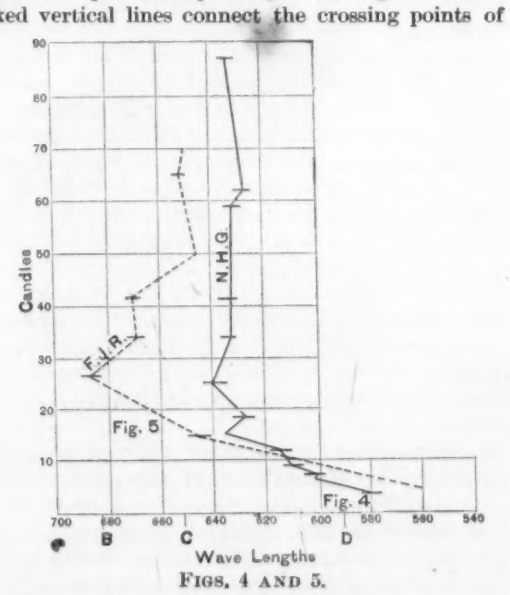


Fig. 3.

descent lamp at six different temperatures disclosed curves similar to those in Fig. 3, with a slight exception. The crossing point apparently moved toward the longer wave lengths of the spectrum, starting at a low temperature, until about twenty candle power was reached, when it directed itself toward the shorter wave lengths as the temperature of the filament was farther increased. Much longer and more carefully observed sets of observations verified this preliminary study. In Figs. 4 and 5 the crooked vertical lines connect the crossing points of the



Figs. 4 and 5.

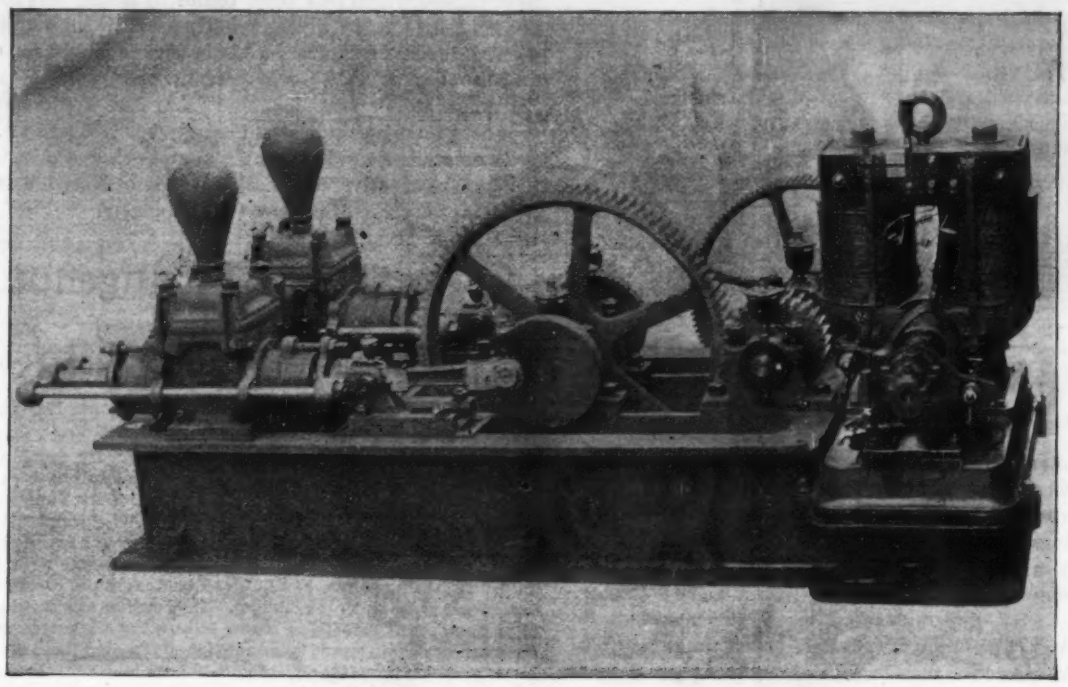
curves taken at the several different temperatures of the lamp filament, by two different observers, denoted by N. H. G. and F. J. R.

A number of sets of observations were next taken by the two observers at temperatures within the range of the incandescent lamp, each observer using the wave length

* From the Cornell *Crank*.

* For a fuller description of this instrument see THE ELECTRICAL WORLD of May 31, 1890, page 368.

which from the curves seemed to be best suited to his individual case. First one observer would set the two photometers alternately until five observations had been taken on each, then the other would take a similar set and so on. In order to avoid the necessity of changing photometer cars, a small Bunsen photometer was mounted directly over the "horizontal slit" photometer on the same car with it. It is eminently proper to call attention to the fact that the settings of one observer were read and recorded by the other, and that after each reading the photometer car was moved to one side at least fifty centimetres and the observer changed his position before the next setting was made. In all the sets on the arc, as well as on the incandescent lamp, not a single observation was rejected, however, far out it might be. By thus not allowing the observer to have the slightest knowledge of any previous settings, he is unbiased in his judgment as to when the lights from the two sources are of equal intensity.



EDISON MOTOR AND DEANE PUMP.

The following table gives these results in which No. stands for the number of observations in each set; λ, the wave length employed; B and H, Bunsen and "horizontal slit" photometer readings in candles. The last two columns for each observer give the mean error of a single observation for each photometer.

		N. H. G., Observer.					F. J. R., Observer.				
		Candle power.		Per cent. mean error, single ob.			Candle power.		Per cent. mean error, single ob.	
No.	λ	B.	H.	B.	H.	λ	B.	H.	B.	H.
10 ...	618	2.37	2.52	3.0	4 5	640	2.37	2.76	3.3	2.5
10....	618	9.06	8.98	2.7	3 8	640	9.15	9.07	2.5	3.0
10....	618	16.15	16.87	2.0	3 5	640	15.89	16.68	2 1	3.5
10....	618	31.06	31 67	1.9	3.6	640	31.57	31.15	2.1	3.0
10....	618	43.58	43.02	2.8	4.2	640	45.12	44.88	3.2	5.7
25....	618	34 05	34.62	2.3	4.1	632	35.25	34.20	2.8	5.3

II. THE ELECTRIC ARC.

In this part of the work the light was taken from the arc at an angle of 35 degrees below the horizontal plane. This was thought to represent the light at its best, at the same time giving a good amount of light from the positive carbon at its hottest point. In order to cancel the fluctuations of the arc, the Bunsen photometer was removed from the "horizontal slit" photometer car and mounted on a separate car at the end of a long projecting arm which would just allow it to pass over the "horizontal slit" photometer. This arrangement enabled the two observers to set the two photometers on the same lights independently and simultaneously. First, however, two Bunsen photometers were used. Twenty-five simultaneous settings on the arc light gave the following results:

	Candle power.	Mean error of single observation.
N. H. G.....	481.7	10 per cent.
F. J. R	479.5	11.6 per cent.

A set of 25 observations was next taken, using the crossing points that had been employed in the incandescent lamp work, and then a set in which both observers used the crossing point recommended by M. Crova, namely, $\lambda = 582$. In order not to tire the eyes by too constant application, the observers exchanged places after every five minutes simultaneous readings.

	Candle power.	Mean error.
F. J. R	Bunsen 508	15.0 per cent.
N. H. G.....	H (λ = 618) 368.5	14.9 per cent.

Reducing each Bunsen reading separately to 500 c. p., in order to cancel the error due to the fluctuations in the lamp, gave 363 c. p. as a mean of the "horizontal slit" readings, with a mean error of a single observation amounting to 6.6 per cent.

The reverse set gave:

	Candle power.	Mean error.
N. H. G.....	Bnsen 513.6	17.6 per cent.
F. J. R.....	H (λ = 632) 341.2	20.5 per cent.

Reduced to Bunsen 500 c. p., the "horizontal slit" reading is 332 c. p.; error, 8.4 per cent.

Both observers employing $\lambda = 582$ gave the following results:

	Candle power.	Mean error.
F. J. R.....	Bunsen 511	18.6 per cent.
N. H. G.....	H 491	17.3 per cent.

Reduced Bunsen 500. H, 483. Error, 7.5 per cent.

Reverse set:

	Candle power.	Mean error.
N. H. G.....	Bunsen 516	14.5 per cent.
F. J. R.....	H 454	14 0 per cent.

Reduced Bunsen 500. H, 441. Error, 5.4 per cent.

two photometers, the observers took up the work one morning, determined to locate the fault. The crossing

These sets not giving the desired agreement between the points for both observers on the arc light were first determined by means of simultaneous readings, and were, to their surprise, found to be almost identical with those used in the incandescent work and in the first set on the arc lamp.

A set of 25 observations was then taken with the following results:

	Candle power.
F. J. R.....	Bunsen 688
N. H. G.....	H (λ = 618) 656

Reduced H., 500. Bunsen, 526. Error for H., 5.6 per cent.

Reverse set:

	Candle Power.
N. H. G.....	Bunsen 594
F. J. R.....	H (λ = 632) 523

Reduced H, 500. Bunsen, 559. Error for H, 5.4 per cent.

In these last observations an increase in the candle power of the Bunsen readings over the "horizontal slit" readings as the work advanced was noticed, which would indicate that the crossing points were moving toward the shorter wave lengths. On completing the set the crossing points were redetermined, and were both found to be not far from $\lambda = 595$.

What is the solution? One suggestion may be offered. The photometry of fluctuating and intensely bright lights is especially fatiguing to the eyes. They soon become less sensitive to the color seen in the "horizontal slit" photometer, and while this does not affect the comparison made with this photometer, it makes the comparison with the Bunsen photometer, a comparison of the lights with this particular color, less effective. As the arc is rich in violet light it is placed to an advantage with the Bunsen photometer as the eyes become tired, while the "horizontal slit" photometer gives it its true worth.

Moonlight Tables for June, 1892.

Herewith we give Mr. H. W. Frund's table of lighting hours for the month of June, under his modified form of moon schedule:

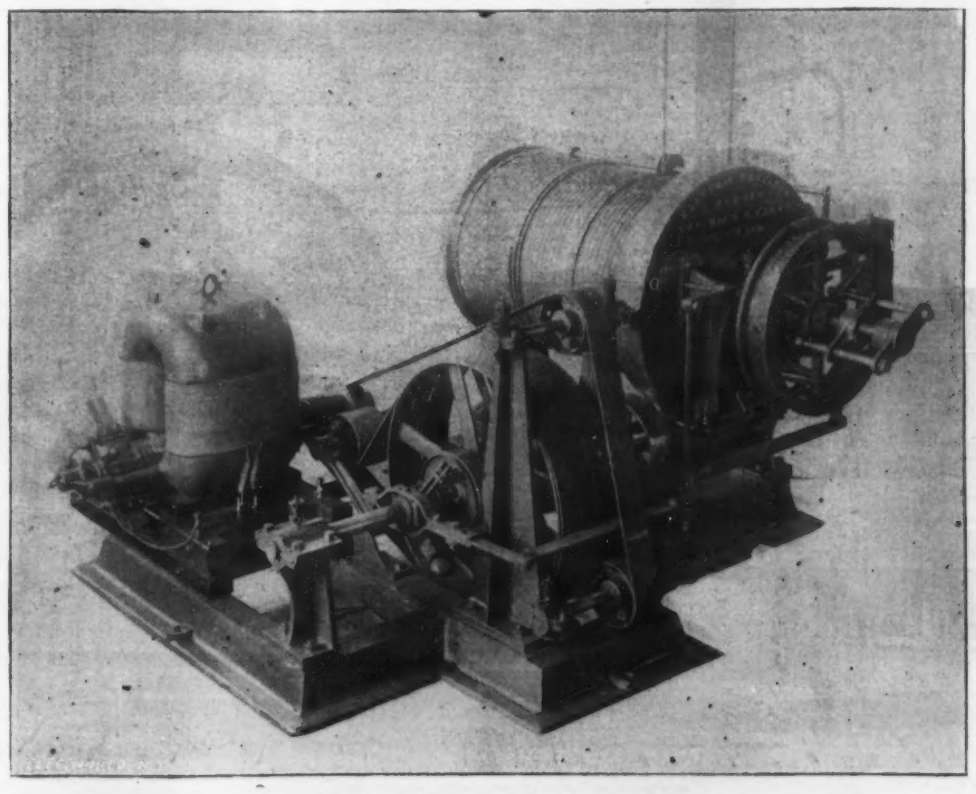
TABLE NO. 1. Standard Moonlight, Philadelphia System.				TABLE NO. 2. Frund's New Moonlight System.			
Date.	Light.	Date.	Exting.	Date.	Light.	Date.	Exting.
1	11:50 P. M.	2	3:35 A. M.	1	7:55 P. M.	2	3:35A.M.
2				2	7:55	3	3:30
3	12:15 A. M.	3	3:30	3	7:55	3	12:00 M.
4	12:35	4	3:30	4	12:35 A. M.	4	3:30A.M.
5	12:55	5	3:30	4	7:55 P. M.	4	12:00 M.
6	1:15	6	3:30	5	12:55 A. M.	5	3:30A.M.
7	1:40	7	3:30	5	7:55 P. M.	5	12:00 M.
8	2:05	8	3:30	6	1:15 A. M.	6	3:30A.M.
9	No light.	9	No light.	6	8:00 P. M.	6	12:00 M.
10	No light.	10	No light.	7	8:00	7	12:00
11	No light.	11	No light.	8	8:00	8	12:00
12	8:00 P. M.	12	10:50 P. M.	9	8:00	9	12:00
13	8:00	13	11:35	10	8:00	10	12:00
14	8:00	15	12:10 A. M.	11	8:00	11	12:00
15	8:00	16	12:40	12	8:00	12	12:00
16	8:00	17	1:10	13	8:00	13	12:00
17	8:00	18	1:35	14	8:00	14	12:00
18	8:00	19	2:00	15	8:00	16	12:40A.M.
19	8:00	20	2:25	16	8:00	17	1:10
20	8:00	21	2:55	17	8:00	18	1:35
21	8:00	22	3:30	18	8:00	19	2:00
22	8:00	23	3:30	19	8:00	20	2:25
23	8:00	24	3:30	20	8 00	21	2:55
24	8:00	25	3:30	21	8:00	22	3:30
25	8:00	26	3:35	22	8:00	23	3:30
26	8:00	27	3:35	23	8:00	24	3:30
27	8:00	28	3:35	24	8:00	25	3:30
28	8.00	29	3:35	25	8:0	26	3:30
29	8:00	30	3:35	26	8:00	27	3:30
30	8:00	1	3:35	27	8:00	28	3:30
				28	8:00	29	3:30
				29	8:00	30	3:30
				30	8:00	1	3:30
Total hours lighting, 133.55.				Total hours lighting, 181.00.			

A New Electric Pump.

A good combination of a pump operated by an electric motor is the equipment which the Edison General Electric Company is about to put on the market. This consists of an Edison standard motor of the type 85, with a Deane duplex double-acting pressure pump upon the same bedplate. These pumps have outside packed plungers, with the valves arranged above the cylinder in such a manner that they can be uncovered for examination or repair without removal of any pipes. The covers of the valve chests are held down by swing bolts. To remove these covers it is only necessary to loosen the nuts and swing the bolts away without removing them. The pump is operated by the motor by means of a double gear. The details and arrangement are shown in the cut.

The Lechtenberg Electric Elevator.

A new method of utilizing electric power in elevator service is shown in the accompanying cut, which illustrates the Lechtenberg system, patented by the Central Machine

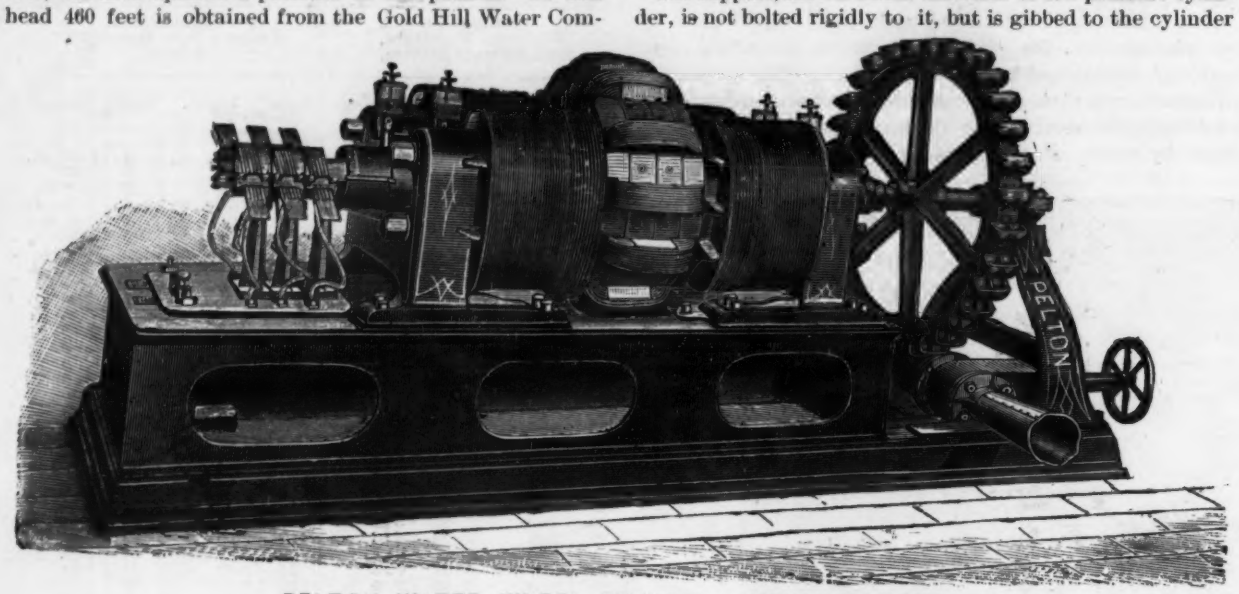


LECHTENBERG ELECTRIC ELEVATOR.

and Foundry Company, of Quincy, Ill. This plant is now in daily operation, raising and lowering a freight elevator, and carrying a maximum load of 2,800 pounds, at an average speed of 45 feet per minute. A five h. p. Eddy motor is double belted to two independent pulleys, each of which is controlled by a Moore & White clutch coupling, and these in turn by the operator's cable. The motor is always in circuit, and the armature rotates constantly in one direction, irrespective of the motion of the elevator. The cable drum is driven by means of the usual attachment.

An Interesting Water-Power Plant.

One of the most extraordinary of water-power installations is that which has recently been made by the Pelton Water Wheel Company in one of the Comstock mines, at Virginia City, Nev. The wheel, which is 36 inches in diameter and made of a solid steel disc with buckets riveted to its periphery, and which weighs only 180 pounds driven by a vertical column of water with a head of 2,100, feet, which is equal to a pressure of 911 pounds. Of this head 460 feet is obtained from the Gold Hill Water Company, and the remaining 1,640 feet from the shaft of the mine down which the pipe line is run to the Sutro Tunnel level, where the power station is located. The wheel is run at 1,150 revolutions, and develops 100 h. p. from the half-inch stream.

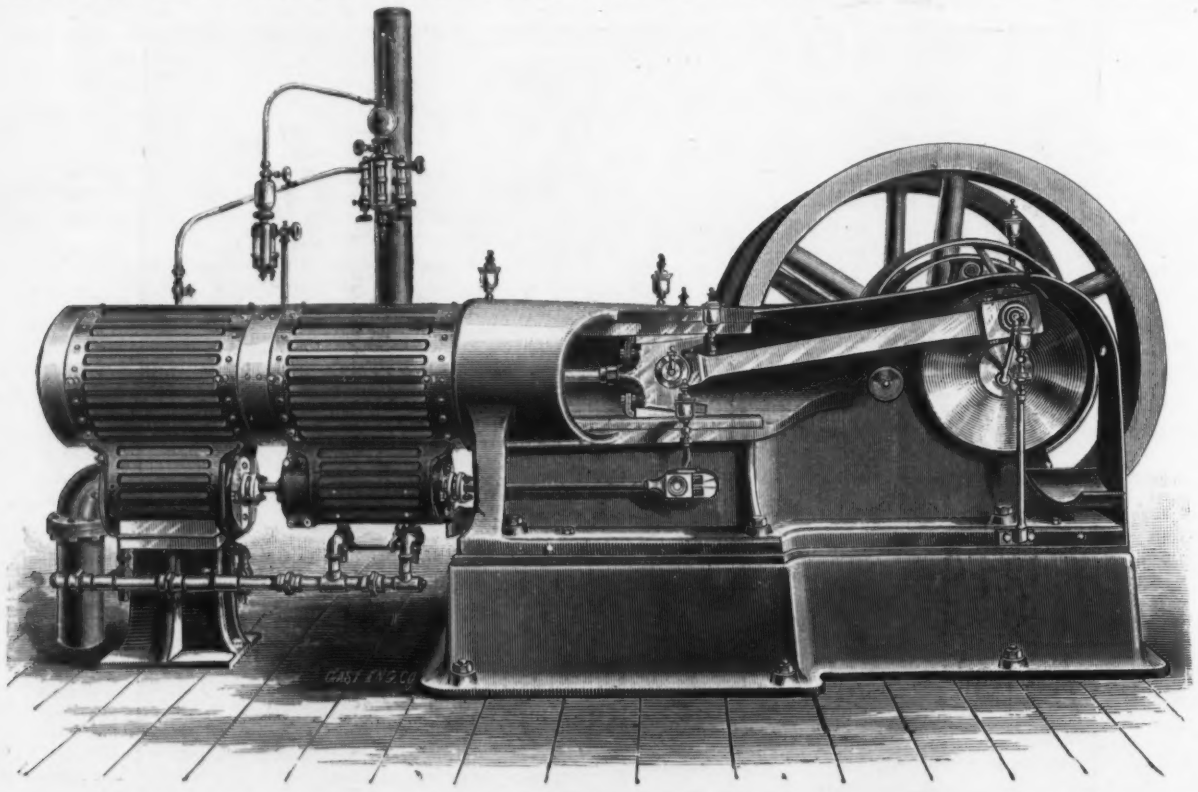


PELTON WATER WHEEL DRIVING A BRUSH DYNAMO.

This installation brings to mind the one made by the same company some two years ago in the Chollar shaft on the Comstock lode. This consisted of six 40-inch Pelton wheels running under a vertical head of 1,680 feet and driving six Brush generators. These wheels weigh 220 pounds each, and with nozzle tips five-eighths of an inch in diameter develop 125 h. p. They are directly connected to the dynamo, as can be seen in the accompanying cut. The water is first run over another wheel on the surface under a head of 460 feet, this wheel being connected to the shaft of the mill. Current from the generators at the bottom of the mine is conveyed a distance of over 2,000 feet to six motors arranged in a parallel row and belted to the main driving shaft of the mill, which they drive in connection with the surface wheel. These two independent sources of power are found to work together very harmoniously. It is claimed that 65 per cent. of the energy developed by the wheels in the mine is available at the mill.

The Taylor Tandem Compound Automatic Engine.

Herewith is illustrated a new tandem compound automatic high speed engine, which has recently been brought out by the Taylor Engine Company, the builders of the well known Taylor-Beck simple automatic engine.



TAYLOR COMPOUND ENGINE.

It will be seen by referring to the illustration cut that the usual distance, or tie piece between the cylinders with the attendant stuffing boxes, has been omitted, and in its place a single cylinder head, containing a set of metallic piston rod packing, is used. It is claimed for this design that it economizes in floor space, that it dispenses with the necessity of keeping two stuffing boxes in proper condition and that it is much more rigid and able to stand a greater amount of use and abuse without injury to the machine.

The high pressure cylinder is placed next to the frame; it is steam jacketed, the jacket receiving the steam through the opening in the top of the high pressure valve chamber. The low pressure piston is made detachable, so as to allow the removing of the head which forms the division wall between the two cylinders. This construction permits of the removal of both pistons for an examination of the cylinder without removing either of the cylinders or disturbing any other parts of the machine.

The support, shown under the outer or low pressure cylinder, is not bolted rigidly to it, but is gibbed to the cylinder in such a manner that when the cylinders expand they are free to slide on the top of the support.

The valves are of the hollow piston type, fitted with adjustable rings, which will compensate for all wear. Both valves are on one rod, can be adjusted independently, and are both connected through the rocker arms to the governor. The relief valves, shown attached to the lower side of the steam chest, are so proportioned that, when the pressure in the cylinder exceeds that in the steam pipe they will open automatically and relieve the cylinder of any undue strain.

The engine is also built after the method most in vogue with compound engine builders, that is, with a "harp" or long exposed connection between the high and low pressure cylinders. In this method of construction the intermediate lagging between the cylinders which obstructs the view of the operation of the piston rods is avoided. The engine frame and other major details of the tandem compound are identical with those of the Taylor standard horizontal automatic engine, so favorably known.

A special feature in this compound engine is that any of the simple engines of the same make already in use can be compounded by simply substituting compound cylinders, thus avoiding the necessity of putting in new foundations and remodeling the whole plant.

In an initial test, reported by the builders, of 100-h. p. non-condensing tandem compound engine, with 9-inch high pressure cylinder, 14½-inch low pressure cylinder, and 13-inch stroke, made with friction brake, the following results were obtained:

The amount of coal was ascertained by actual weight. Three thousand pounds were first placed in front of the boiler, and when the test was finished the remainder was carefully weighed and the number of pounds deducted from the above amount. This was done so that the fireman should not be restricted in the amount of coal burned, but should have the conditions as near the same as found in boiler rooms generally.

The steam pressure carried was 100 pounds by gauge.

The horse power was determined from indicator cards taken at regular intervals (every hour). The mean effective pressure of cards was determined from planimeter readings.

Duration of test	11 hours
Speed of engine, per minute	265 revolutions
Boiler pressure	100 pounds
Diameter of high pressure cylinder	9 inches
Diameter of low pressure cylinder	14½ inches
Stroke	13 inches
Average indicated horse power	95
Total amount of coal consumed	2,134 pounds
Coal consumed per hour	194 pounds
Coal consumed per indicated horse power per hour	2.04 pounds

Assuming the evaporative efficiency of the boiler to be nine pounds of water for one pound of fuel burned, the water consumption per indicated horse power per hour would be 18.36 pounds.

The coal used was of an inferior grade of Pennsylvania bituminous, which had been found by actual test to be 20 per cent. inferior to that generally used for such tests. If coal of the better quality had been used it would have materially decreased the coal consumption, possibly 20 per cent., and 20 per cent. deducted from 2.04 would leave the coal consumed per indicated horse power 1.63 pounds.

These engines are built at the company's works at Chambersburg, Pa. The New York office is at Nos. 163 and 165 Washington street, Cooke & Co., managers.

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

New York, May 21, 1892.

Review of the Market.—An account of the stock market of the past week, if it were complete, would read very much like the diary of a beginner who had nothing to chronicle but his regular rising in the morning, three meals a day and retiring at night. That is to say, the market opens each day and goes through a regular routine of business, with the usual number of sales, and closes at night, having transacted no business of interest and with no new influences having arisen to stimulate business outside of the professional brokers on the exchanges. A short time ago there seemed to be promises of something more interesting than this, but the situation has again lapsed into one of inactivity, and there is nothing in view which promises anything to change matters. Prices fluctuate as usual, and there is no probability that they will go any lower, for they now show an unusual decrease below the highest prices of the year. The bond market continues quite active, principally in municipal issues, and these offer attractive channels for large sums of money, although the rates are naturally low for this kind of loans. The money market remains featureless and the rates are unchanged.

The Electric Stocks have partaken of the same inactivity and slight manipulation that has characterized the rest of the list. The sales have been very few, and in nearly every case show lower prices than last week. The market is evidently too weak and unsettled even to maintain the activity in these stocks that was so gratifying a week ago, and they will probably remain very quiet for a period now until some item of news is reported to stimulate the interest and raise prices once more. It will be only a short time to the completion of the plans that will finally launch the General Electric Company into activity as an individual company, and with that will come also a settlement of the matters pertaining more particularly to the stock, and what interests are really to be combined with the Thomson-Houston and Edison companies. Thomson-Houston and Edison stocks are both lower by two points than last week, but the sales have been very few and the loss is due only to the general prevailing conditions. Fort Wayne lost twice the amount of its dividend. It now sells on the basis of eight per cent. and evidently offers a good investment to stockholders, as it always has. Westinghouse closed at the end of the week at a considerable loss from previous figures, developing apparent signs of weakness in its support. Western Union and Bell Telephone are only fractionally changed and both are strong. Kiernan's News Agency in its issue of May 20 had the following in regard to Western Union: "Insiders in Western Union reiterate the statements as to the prosperous condition of the property, but declare that any startling development in the company's affairs at the June meeting is improbable. At the October meeting, however, they look for history to be made."

The General Electric Company.—The General Electric Company issues notice that it has authorized the creation of a series of five per cent. gold coupon debenture bonds, not to exceed $10,000,000, payable June 1, 1922, interest payable June and December. The company offers holders of stock and receipts the right to subscribe to $4,000,000 in proportion of one $1,000 bond for 85 shares of stock, or equivalent in receipt issued by the New York Guaranty and Indemnity Company, and the Old Colony Trust Company, at 95 and accrued interest. Subscriptions must be filed on or before 12 M., June 7. On every $1,000 bond $476.46 will be due June 22 and the balance July 22, when bonds will be delivered. The entire issue of $4,000,000 has been underwritten.

The Detroit Electrical Works.—In a recent trade review, issued by the *Evening News*, of Detroit, Mich., the following among other comments was stated in regard to this company: "This institution was founded by the present company in 1879, and is incorporated with a capital stock of $2,000,000; $1,000,000 of which has been issued. There are at present 220 hands employed in the factory, and the annual output is valued at $750,000, the apparatus being sold in every section of the country. The official management is characterized by an enterprising and judicious direction, and the industry justly takes rank among the largest and most important of its character in the world. The capital stock has been increased from time to time as required by the growth of the business until it has reached its present limit, the business meanwhile under progressive impulse has expanded from its pristine identity as manufacturing electrical supplies to its present extensive proportions, embracing every department of applied electricity."

The American Rapid Telegraph Company.—This company has again come before the public, after its long period of quietness. This time it is with a scheme for reorganization. Under date of March 31, a circular was issued about a week ago signed by J. W. Converse, J. Sawyer, C. B. Lancaster, G. H. Quincy, E. L. Giddings, the committee under the bondholders' agreement. The circular is quite lengthy and reviews the different phases of the company's history; the sale of the property to the Bankers' and Merchants' Company; the appointment of General Harland as receiver; the contract with the Western Union Company, which was to operate the property under the receiver at $5,000 per month; and finally the sale in foreclosure when the property was sold at auctio

and bought in by the Bondholders' Committee for $100,000. A committee of bondholders of the company reports its inability to find a satisfactory purchaser for its property, and accordingly recommends this plan of reorganization. The property of the American Rapid Telegraph Company was bid in at the foreclosure sale by the bondholders' committee for $100,000. Every bondholder is offered the election: either to share in the benefit of this purchase by becoming a party to the reorganization scheme; or to accept the final dividend upon the basis of this sale and a distribution of the surplus of earnings accumulated through the receivership, which will amount altogether to about 10 per cent. upon the par of the bonds. The reorganization scheme is as follows: It is proposed to form a new telegraph company, to be properly incorporated, which company shall acquire the property and franchises of the American Rapid Telegraph Company, being all the property which was sold in the foreclosure proceedings. The capital of this new company to represent, substantially, the par of the bonds assenting to the scheme; each assenting bondholder to receive an amount of the stock at par equivalent to the amount of his bonds at par, and to surrender his bonds in exchange for the stock. The new company to enter upon the operation of the property and the conduct of the telegraph business, with an especial view to the development of an extensive leased wire and private line business. The surplus remaining of the earnings accumulated during the receivership, after paying the final dividends on the basis above stated to those bondholders who may elect not to come into the reorganization, to be employed for improvement of the property and as a working capital. Additional cash capital, if it should prove requisite, to be raised by the issue of a limited amount of preferred stock, at par. In consultation with a number of bondholders, the following persons were agreed upon to act as a reorganization committee, with the power to fill any vacancies in said committee, and to be entrusted with the arrangement of details and to have the general charge of carrying out the scheme: Spencer W. Richardson, Hon. Charles R. Codman, George A. Alden, Col. A. A. Pope, Hon. E. S. Converse.

The International Bell Telephone Company (Limited) is the sole operator of the telephone system in Europe. Not much is heard about the company in this country, but it is eminently successful, and its stock is over par. At the recent annual meeting in New York the following figures were presented showing the company's condition:

ASSETS.

Russian construction, concessions, patents, etc	$1,432,144
Shares in sub-companies	361,706
Deposits	22,137
Taxes on advance subscriptions for 1892	17,907
Instruments and materials on hand	59,220
General expenses, rent, etc., in advance	8,116
Sundry debits	5,218
Bills receivable	97,106
Furniture	1,828
Cash and bankers	170,599
Total	$2,175,986

LIABILITIES.

Capital stock ($1,700,000 authorized)	$1,297,200
Sundry credits	135,550
Subscriptions for 1892 in advance	98,387
Reserve fund	80,803
Sinking fund of Russian capital	387,160
Profit and loss balance	176,884
Total	$2,175,986

PROFIT AND LOSS.

To head office, expenses, etc	$19,861
To sinking fund Russian capital	104,299
To dividends on capital stock	116,748
To balance	176,884
Total	$417,793
By profit on exploration, dividends, sales of shares, etc.	417,793

The Mexican Telephone Company's annual report for the year ending Feb. 29, 1892, shows gross receipts in Mexico for year ending Feb. 29, 1892, $79,565.22; gross receipts, home office, $1,231.71. Disbursements in Mexico for year ending Feb. 29, 1892, $66,374.52; disbursements in home office for year, $20,882.15. Total receipts home office for the year (including cash balance, $12,100.19), $27,231.83, leaving cash balance in treasury of $6,349.68.

ANNUAL COMPARATIVE STATEMENT.

	1890-91.	1891-92.	Increase.
Telephones in service	1,123	1,241	118
Monthly rentals (March 1)	$5,626 00	$6,263.00	$637.00
Rentals collected for the year	66,782.17	70,764.20	3,982.03
Gross receipts in Mexico	76,068.79	79,565.22	3,496.43
Gross operating expenses in Mexico	41,818.15	42,133.94	315.79
Net earnings in Mexico	20,810.10	29,697.81	8,887.71
Net increase in assets	4,866.35	28,037.26	23,170.91
Net receipts from all sources	12,594.97	21,306.87	7,711.90

The annual balance sheet, March 1, 1892: Assets, $2,215,784.11, which includes rights, franchises and contracts, $1,500,000; liabilities, not including capital stock, $215,784.11.

West End Railway.—The following shows the sales and prices of West End Railway stock at auction during each day this week:

Date.	No. of shares.	Rate.	Amount.
May 16	2,000	74.96	$149,375 00
" 17	2,000	74.82	149,643.75
" 18	2,000	74.26	148,537.50
" 19	2,000	74.16	148,325.00
" 20	2,000	74.52	149,037.50
" 21	2,000	74.14	148,275.00
Total 12,000 shares			$893,193.75
The same if sold at par			600,000.00
Premium realized			$293,193.75
Total sale of shares to date			36,000
Aggregate realized			$2,662,805.75
Par value			1,800,000.00
Premium			$862,805.75

Annual Reports.—The annual report of the Westinghouse Electric and Manufacturing Company is given elsewhere in this issue of THE ELECTRICAL WORLD. The Middleboro Gas and Electric Company, of Middleboro, Mass., has filed the following annual statement through its treasurer, William A. Carey: Fixed capital, $80,000; capital paid in, $80,000. Assets—Water power, $42,052; buildings and land, $28,475; electric and steam plant, etc, $93,591; cash and debts receivable, $265; manufactures and merchandise, $3,898; franchise, $4,530; miscellaneous, $89; profit and loss, $12,064; total, $184,968. Liabilities—Capital stock, $80,000; debts, $24,968; bonds, $80,000; total, $184,968. The Plymouth, Mass., Electric Light Company has filed its annual statement through its treasurer, W. A. Carey, as follows: Fixed capital, $40,000: capital paid in, $40,000. Assets—Land, $2,464: buildings, $6,745; machinery, $88,515; cash and debts receivable, $2,330; manufactures and merchandise, $2,186; patent rights and licenses, $8,000; miscellaneous, $202; profit and loss, $1,457; total, $111,901. Liabilities—Capital stock, $40,000; debts, $41,901; bonds, $30,000; total, $111,901.

Decrease in Capital Stock.—The Morrison, Ill., Electric Light and Power Company has decreased its capital stock from $25,000 to $20,000.

Closing Quotations.—The following were the closing quotations of electric stocks, on Saturday, May 21, 1892, in New York and Boston:

NEW YORK QUOTATIONS.

Name of Stock.	Par.	Capitalization.	Bid.	Ask'd.
American Cable	...	.....	84	85
American Telegraph Co.	100	14,000,000	60	63
Western Union Telegraph Co.	100	86,200,000	92⅝	92¾
Commercial Cable Co.	100	7,716,000	155	160
Edison General Electric	100	15,000,000	101⅛	111⅛
Edison Illuminating Co., of New York	100	4,500,000	79½	80
" " " Brooklyn	100	750,000	76	80
" " " Chicago	100	750,000	138	142
U. S. Illuminating Co.	100	1,250,000	30	35
Edison Elec. Light Co. (of Europe) stock	100	2,000,000	2¼	5
Edison Elec. Light Co. (of Europe) bonds	sh	30,000	65	75½
" Ore Milling Co	100	2,000,000	15	20
" Toy Phonograph Mfg. Co	10	1,000,000	....	⅛
Brush Illuminating Co., of New York	50	1,000,000	40	50
Mt. Morris Electric Light Co.	...	500,000	20	40
East River Electric Light Co.	100	1,000,000	....	60
North American Phonograph Co.	...	6,600,000	5	8
New York Phonograph Co.	...	2,000,000	3	4
Automatic Exhibition Co.	...	2,000,000	3	6
New England Phonograph Co.	...	2,000,000	1¾	2¾

BOSTON QUOTATIONS.

	Par.	Capitalization.	Highest.	Lowest.	Bid.	Ask'd.
Thomson-Houston Elec.	25	6,000,000	66⅝	65⅛	65⅛	65¾
Thomson Houston Elec. preferred	25	4,000,000	30¼	29¾	30⅛	30¼
Thomson-Houston Elec.—Series C	sh	40,000	....	....	8⅛	9
Thomson-Houston Elec.—Series D	sh	120,000	7¼	7	7⅛	7¼
Thomson-Houston Int'n'al Elec.	100	600,000	....	....	....	240
Thomson-Houston Int'n'al Elec—Pfd.	100	400,000	....	....	103	105
Thomson Elec. Weld.	100	1,000,000	....	....	...	55
Thomson European Elec. Weld	100	1,500,000	....	....	10	15
Westinghouse Elec.—New Com.	..	6,000,000	30	27½	28	28¼
Westinghouse Elec.—Pfd.	..	4,000,000	45½	45	45	46
" " —						
Fort Wayne Elec.	25	4,000,000*	12⅛	12¼	12⅜	12⅝
Fort Wayne Elec.—Ser. A.	sh	80,000	7½	....	7⅞	7½
Detroit Elec.	10	1,000,000	....	....	....	....
West End St. Ry. Co.—Com	50	7,150,000	75⅜	74	74⅝	74¾
West End St. Ry. Co.—Pfd	50	6,400,000	88¾	88	88⅝	88½
American Bell Tel	100	15,000,000	208	206	207	208
Erie Tel. & Tel. Co.	..	4,800,000	46⅞	45¾	45	46
Mexican Tel. Co.	10	1,280,000	....	....	100	105
New Eng. Tel. & Tel. Co.	..	10,304,600	53	52⅜	52½	53
Tropical Tel. Co.	10	400,000	....	....	....	30

NEW INCORPORATIONS.

The Enterprise Electric Company, of Chicago, Ill., capital stock $25,000, has been formed to buy, sell and deal in electrical supplies. Wm. F. Richardson, F. P. Hill and W. C. McKinlock are the promoters.

The Boulder Electric Power Company, of Creighton, Neb., capital stock $500,000, has been formed to operate mines in Park county, Mont. The organizers are A. N. Hawley, L. P. Ash and Charles W. Hamilton.

The Brookwood Traction Company, of Harrisburg, Pa., capital stock $10,000, has been formed to construct electric motors, etc. N. Hamilton, Christian W. Lynch and John E. Fox, of Harrisburg, Pa., are those interested.

The Physicians' Electrical Supply Company, of Lafayette, Ind., capital stock $50,000, has been formed to manufacture and sell electro-medical batteries, etc. Chas. G. Longyear, Wm. D. Hyslop and Wm. G. Churcher are the promoters.

The Rockbridge Hotel, Power and Electric Company, of Glasgow, Va., capital stock $150,000, has been incorporated to erect electric plants, etc. D. Axtile, H. W. Fuller, F. Huges, W. B. Berill and Fitzhugh Lee are the parties interested.

The Yonkers Machine Company, of Yonkers, N. Y., capital stock, $5,000, has been formed to manufacture and sell machines, erect electric light plants, etc. Rudolph Eickemeyer, Norton P. Otis and William Delavan Baldwin, all of Yonkers, are the incorporators.

The Bloomfield Street Railway Company, of Pittsburgh, Pa., capital stock $12,000, has been started to construct and operate an electric street railway. Joshua Rhodes, John G. Fraghardh and Geo. M. Von Bonnhorst, of Pittsburgh, Pa., are the incorporators.

Thomas Day and Company, of San Francisco, Cal., capital stock $300,000, has been formed to manufacture and sell electric fixtures. The incorporators are Frank J. Symmes, Vanderlyn Stow, S. O. Bigelow, H. T. Clay and E. J. Duffey, all of San Francisco, Cal.

The Cicero Light, Heat and Power Company, of Cicero, Ill., capital stock $150,000, has been started to furnish electric light, heat and power for street, commercial, manufacturing and household purposes. E. L. Jeffery, H. P. Lucas and H. P. Brauns are the incorporators.

The Standard Electric Heat, Light and Power Company, of Portland, Me., capital stock $500,000, has been started to generate and deal in electricity. Robert J. Edwards, Frank Q. Brown, Boston, Mass., and Chas. A. Campbell, of Chelsea, Mass., are the promoters.

The John L. Gisk Ideal Rheostat Company, of Jackson, Mich., capital stock $10,000, has been formed to manufacture and sell the John L. Gisk rheostat and electrical appliances, etc. Clarence H. Bennett, John L. Gisk and Charles H. Smith, all of Jackson, are the promoters.

The Universal Electric Company, of New York, capital stock $2,000,000, has been incorporated to buy and sell letters patent relating to the application of electricity to various commercial objects. C. W. Keep, R. L. Keen and G. P. Platt, of New York City, are the incorporators.

The Galesburg Electric Motor and Power Company, of Galesburg, Ill., capital stock $210,000, has been formed to construct and operate an electric plant for furnishing light, heat and power. P. M. Johnson, E. A. Bancroft, William Kellogg and Henry F. Arnold are the promoters.

The Hope Electric Light and Power Company, of Cartersville, Ill., capital stock $20,000, has been formed to furnish light and power to corporations and individuals. A. C. Hope, J. V. Walker, R. H. H. Hampton, W. H. Zimmerman and F. C. Zimmerman are the incorporators.

The Prospect Street Railway Company, of Ashtabula, O., capital stock $10,000, has been formed to build, operate and maintain a street railway to be operated by electric or other power. James Reed, S. F. Conant, C. H. Blakeslee, F. C. Moore and Frank Luce are the incorporators.

The Pullman Electric Light and Power Company, of Pullman, Wash., capital stock $25,000, has been formed to operate light and power plant, and to furnish light and power for any purpose. H. H. Cheatam, S. A. Mudge and Alexander McKenzie, all of Pullman, are the promoters.

The Hoke Electric Belt Company, of Camden, N. J., capital stock $100,000, has been formed to manufacture and sell the electric appliances of Prof. C. U. Hoke. The promoters are C. U. Hoke, M. C. J. Stupp, of Reading, Pa.; H. Becker, of Philadelphia, and F. S. Warren, of Pensaukin, N. J.

The Pernaux Electric Company, of New York City, capital stock $2,000, has been formed to manufacture electrical instruments. C. Louis Yorston, 20 East Seventeenth street, New York City, Jas. M. Croll, 185 Baltic street, and Jas. Levre, 19 Pilling street, Brooklyn, N. Y., are the promoters.

The Gate City Electric Street Railway Company, of Keokuk, Ia., capital stock $130,000, has been formed to operate an electric street railway at Keokuk. Wm. Logan, S. P. Townsend, G. S. Dana, Wm. J. Roberts, H. H. Richardson and H. G. Reimer, all of Keokuk, are the incorporators.

The Edison Electric Light and Power Company, of Trenton, N. J., capital stock $200,000, has been incorporated to furnish electric light and power by means of electricity to any and all persons and corporations. F. A. Magowan, W. P. Hayes, Trenton, N. J., and F. Z. Magurie, of Washington, D. C.

The Canton Electric Light, Heat and Power Company, of Canton, Pa., capital stock $10,000, has been formed to supply light, heat and power by means of electricity. J. W. Parsons, W. C. Crippen, H. B. Parsons, of Canton, Pa., and C. W. Carrier, of Troy, Pa., are those interested.

The New England Therapeutic and Alarm Company, of Biddeford, Me., capital stock $100,000, has been formed to manufacture and deal in electric appliances and apparatus. John H. Roberts, Chelsea, Mass.; Geo. E. Fowle, Wilbur L. Libbey and John Winn, of Boston, Mass., are the incorporators.

The Cumberland Development and Improvement Company, of Castle, Mont., capital stock $60,000, has been started to manufacture and use electricity for light, heat and power, etc. The promoters are as follows: Chas. E. Severance, Chas. B. Carr, Oka, Mont., and A. J. Muncke, of Castle, Mont.

The West India and Colombia Electric Company, of Chicago, Ill., capital stock $500,000, has been formed to do a general telegraph and telephone business and to furnish electricity for light, heat and power, street railways, etc. John P. Dieter, Wm. G. Adams and John H. Miller are the incorporators.

La Grange Light and Water-Works Company (incorporated in West Virginia), of New York City, N. Y., capital stock $125,000, has been formed to construct and operate electric light and water works in La Grange. H. C. Hodgkins, C. T. Moffatt and Chas. F. McLain, of Syracuse, N. Y., are the incorporators.

The Railway Equipment Company, of Chicago, Ill., capital stock $100,000, has been formed to manufacture the machinery and merchandise used by electric railways, etc., and dealing in electric heating apparatus and other appliances. The incorporators are C. Metterhausen, A. E. Woodward and Ralph Bottemus.

The Kankakee Electric Light Company (incorporated in W. Va.), of New York City, capital stock $10,000, has been organized to construct and operate an electric light system at Kankakee, Ill. J. F. Moffatt, Watertown, N. Y.; J. V. Clarke, New York City; H. C. Hodgkins, Syracuse, N. Y., are the incorporators.

The Nicaragua Water, Irrigation and Electric Company, of San Francisco, Cal., capital stock $250,000, has been incorporated to deal in electric lights, etc., in Nicaragua, J. I. Jewell, G. C. Jewell, Petaluma, Cal.; W. C. Quinby, A. P. Bacon, San Francisco, and W. F. Russell, of Santa Rosa, are the parties interested.

The Fiberite Company, of Ballston Spa, N. Y., capital stock $20,000, has been formed to manufacture, buy and sell fiberite conduits and battery cells and other electrical specialties. Horace J. Medbery, and Stephen C. Medbery, of Ballston Spa, N. Y., and Franklin Acker, 132 Chambers street, New York City, are those interested.

The Delaware County and Philadelphia Electric Railway Company, of Chester, Pa., capital stock $120,000, has been formed to construct and operate an electric railway in Delaware county. Wm. H. Sayer, Wayne, Pa.; Jas. S. Austin, Lansdowne, Pa., and Edward V. Kane, also of Lansdowne, are the incorporators.

The Atlantic & Western Telephone Company, of Chicago, Ill., capital stock $5,000,000, has been incorporated to manufacture and use and license others to use speaking telephones throughout the United States. H. P. Caldwell, H. C. Strong, D. A. Strong, E. B. Springer, C. J. M. Porter and G. N. Brinkerhoff are the promoters.

The Indianapolis Light and Power Company, of Indianapolis, Ind., capital stock $600,000, has been formed to manufacture and distribute electricity for light, power, etc., also to manufacture and sell electrical machinery. The incorporators are Daniel W. Marmon, Charles C. Perry, Wm. R. Evans, Harry Schnull, Frank A. Maus and Clarence Wulsin.

The Chicago Twin-Wire Long Distance Telephone Company has been incorporated in Chicago; capital stock $2,500,000. A. P. Hunneman, W. S. Bates and Robert D'Unger are the incorporators. A petition for a franchise is in the hands of the Judiciary Committee of the Council. The company, which has the D'Unger patents, proposes to place 10,000 telephones in Chicago. Its rates will be $75 for a business telephone, and where one is placed in a residence, also, $25 additional.

The Lewiston & Youngstown Railroad Company has been incorporated with a capital of $75,000 to construct and operate a standard gauge railroad to be operated by electricity, or other motive power. The road will be about seven miles in length, and will run from a point near the wharf on the Niagara River in Lewiston, Niagara county, New York, to the northerly bounds of the village of Youngstown, in that county. The directors are: Walter D. Hough, W. H. Woolworth, Asher T. Cuddaback, William A. Philpotte, Sr.; Elmer Z. Burns, Thomas McDowell, W. A. Philpotte, Jr.; Frederick Luppie and Spencer J. Lawrence.

AFFAIRS OF THE COMPANIES.

Receiver Appointed.—W. J. Keller has been appointed receiver of the North Dallas (Tex.) Railway Company by Judge Burke upon the application of the Thomson-Houston Electric Company.

The Continental Telegraph Company held its annual meeting in Philadelphia recently and elected the following officers: President, James Merrihew; directors, Charles A. Tinker, R. H. Rochester, W. B. Gill and Henry Bentley.

The Delaware River Telegraph Company held its annual meeting in Philadelphia recently and elected officers as follows: President, Charles A. Tinker; directors, W. B. Gill, John Van Horn, Charles A. Tinker, R. H. Rochester, James Merrihew and Henry Bentley.

The Pacific & Atlantic Telegraph Company at its recent annual meeting held in Philadelphia elected the following officers: President, Norvin Green; directors, Thomas T. Eckert, W.

B. Gill, James Merrihew, Roswell H. Rochester, Charles A. Tinker and Henry Bentley.

The Hamburg Water & Electric Light Company, of Hamburg, N. Y., at a recent annual meeting chose the following directors: Daniel N. Lockwood, T. L. Bunting, George M. Pierce, John F. Burke, B. S. Spencer and Jacob Peffer. Jacob Peffer was re-elected superintendent.

The Haverstraw Electric Light and Power Company, of Haverstraw, N. Y., at its recent annual meeting elected officers as follows: B. B. Odell, Jr., president; Gardiner Van Nostrand, treasurer; H. B. Odell, secretary; directors, B. B. Odell, Jr., G. Van Nostrand, M. H. Hirschberg, C. L. Waring.

The Philadelphia Local Telegraph Company recently held its annual meeting in Philadelphia, when the following officers were elected: Henry Bentley, president; W. B. Gill, vice-president and general manager; W. P. Wheatland, secretary and treasurer; directors, Henry Bentley, James Merrihew, C. A. Tinker, John Van Horn and W. B. Gill.

The People's Electric Light Company, of York, Pa., at its recent annual meeting elected the following directors and officers: Directors, Horace Keesey, C. A. Eisenhart, J. V. Giesey, W. F. Bay Stewart, William A. Miller, R. F. Polack, Frank Dehoff; president, Horace Keesey; vice-president, C. A. Eisenhart; J. V. Giesey, treasurer.

The Baxter Overland Telephone and Telegraph Company held its annual meeting at Utica, N. Y., recently and elected the following directors and officers: Charles L. Bartlett, Palmer M. Wood, T. Jay Griffiths, B. D. Gilbert, John Doyle, H. J. Coggeshall, A. W. Mills, Judson T. Stevens, I. H. Fay, Louis Friede, W. H. Cloher, Jr. P. M. Wood was made chairman and A. W. Mills secretary. A balance of $392.54 was reported on hand.

The Home Electric Light and Power Company, of Muscatine, Ia., is the title of a new company which recently purchased the plant of the Citizens' Electric Light Company which was sold at assignee's sale for $10,100 to F. P. Sawyer, of Muscatine. The new company has been capitalized for $150,000, and until the annual meeting Jan. 1, 1893, will have the following officers: President, S. G. Stein; vice president, A. M. Barnhart, Chicago; secretary and treasurer, F. P. Sawyer.

The Peninsula Electric Light and Power Company, of Newport News, Va., at its recent annual meeting elected officers as follows: E. C. Hillyer, president; L. P. Stearnes, vice-president; W. W. Archibald, secretary; Geo. B. West, treasurer. Directors: H. E. Parker, D. S. Jones, A. C. Jones, J. B. Jennings, T. M. Benson and Theo. Livesey. Mr. E. C. Hillyer, the president, submitted his first annual report of the affairs of the company. It seems that the plant as at present working cost $33,426.29. The cost of labor is $350 per month, and fuel costs $300 per month. The monthly revenue is $1,058.

The Detroit Electrical Works, at its recent annual meeting, elected the following directors to serve during the ensuing year: Messrs. Hugh McMillan, W. H. Wells, T. H. Newberry, Gilbert N. McMillan, James H. McMillan, Strathearn Hendrie, Louis Warfield, all of Detroit; and Messrs. Albert A. Pope and George B Strong, of Boston. The following officers of this company were elected by the board of directors at a meeting held May 17: Hugh McMillan, president; Louis Warfield, vice-president and general manager; Joseph E. Lockwood, secretary; Thos. Muir, treasurer; H. C. Van Husen, assistant secretary.

The street railway at Chillicothe, O., has been recently purchased by George F. Woolston and associates, of New York City. This road was rebuilt two years ago and has been operated by horse power. Mr. Woolston will proceed at once to equip it with the latest improved electric system. This purchase by Mr. Woolston is quite an important one, although Chillicothe is not a very large city. There was considerable competition, as street railroad parties in Chicago and Cleveland were competing for this road, but Mr. Woolston secured it. The purchase price is not positively stated, but it is understood that the consideration was $75,000.

The Denver Consolidated Electric Company, of Denver, Colo., at its annual meeting, held recently, elected officers and directors as follows: Directors, E. W. Rollins, John Gray, W. G. Fisher, N. M. Tabor, John H. Poole, James H. Morris, Thomas E. Poole, A. E. Grier, H. A. W. Tabor, H. K. Devereux and Andrew S. Hughes. Officers: E. W. Rollins, president; N. M. Tabor, vice-president; J. H. Morris, secretary; A. E. Grier, treasurer; John W. Flintham, general manager. The annual report of the manager detailed largely the construction of the western plant, located on Sixth and Lawrence streets. This plant is, it is stated, one of the most complete and perfect electric light plants in the country, equipped with every modern appliance for the production of electric light.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
167-176 TIMES BUILDING, NEW YORK, May 23, 1892.

The Crocker-Wheeler Company is working until 9 P. M. every week day. Armature winders take notice.

F. H. Leonard, of the Electric Engineering and Supply Company, Syracuse, made his many New York friends happy by calling on them last week.

W. H. Fitzgerald, general manager of the Detroit Electric Light and Power Company, Detroit, Mich., left several good orders in New York last week.

Eugene F. Phillips, president American Electric Works of Providence, when in New York the other day said that the crop of clams this year was immense and it looked as though some of them would have to be eaten before the season was over.

The Postal Telegraph Company's new building, which is to be erected at the corner of Broadway and Murray street, this city, opposite City Hall Park, will be 13 stories high, and will cost $750,000. The plans call for a magnificent structure.

McLeod Ward & Co., of Liberty street, this city, have just finished installing 1,500 incandescent and six "Ward" arc lights in the factory of the New York Biscuit Company. The power plant consists of one Armington & Sims engine, one Billberg dynamo and one 100 h. p. Billberg motor.

Messrs. Read & McKibben, 2 Wall street, this city, are, as usual, very busy. They have just completed an extension of the Weygadt Mountain Electric Railway, at Easton, Pa., are doing the overhead work for the 25 miles of new railway at Fall River; laying the track for three miles of the Camden Horse Railroad Company, Camden, N. J., and are engineers for the Paterson Central Electric Railway, Paterson, N. J.

The Hero Electric Company has opened a factory at 78 Cortlandt street and offices at 80 Cortlandt street, succeeding to the business of Jno. F. Bahr & Co. The new officers of the company are: W. H. Russell, president; D. P. Westervelt, secretary; and J. B. Varick, for eight years with the Edison General Electric Company, will be general manager, and J. F. Bahr, superintendent. They will manufacture the Hero battery, Hero motor, Conqueror battery and Bahr magneto bell.

Mr. Alex. Churchward, well known from his long connection with the dynamo and motor business, is now electrician for the Easton Electric Company, 643 Kent avenue, Brooklyn, N. Y. The Easton company have recently perfectly a new arc governor for their arc light machines, a new and simple arc lamp for incandescent circuits, and are manufacturing a new and improved style of motor in sizes from ⅛ to 65 h. p. Business is brisk with them, their sales increasing daily.

Mr. Henry B. Oakman, the Edison agent at Buffalo, N. Y. has been mentioned as the local agent for the General Electric Company at that city, as his many friends will be glad to hear. Mr. Oakman's career commenced as office boy with the Electrical Supply Company, New York City, so that he has grown up in the electrical business. Although rapidly advanced in the service of that company, in January, 1887, he connected himself with the Long Distance Telephone Company, and later organized and became treasurer of the Empire Manufacturing Company, of New York City. In 1891 he attached himself to the Edison General Electric Company, and some time afterward was placed in charge of their offices in Buffalo.

W. F. D. Crane, who has been widely and favorably known as manager of the Railway Department of the Engineering Equipment Company, has recently become connected with the H. W. Johns Manufacturing Company, 87 Maiden Lane, New York, and will hereafter have charge of the electrical department of that company. Announcement has been made of the consolidation of the Molded Mica insulating business of the Gould & Watson Co., of Boston, with the Johns Pratt Co., of Hartford. The mica trolley line insulating materials have entered into the construction of numerous electric railways and are well known in overhead construction. The Vulcabeston insulating material, manufactured by the Johns Pratt Company, is also well known to makers and users of electrical machinery. Mr. Crane will give his special attention to the further development of the already large business of the H. W. Johns Manufacturing Company, selling agent of these materials.

L. H. H.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 28, Hathaway Building, 620 Atlantic Ave.,
BOSTON, Mass., May 21, 1892.

The Rhode Island Electric Protective Company, of Providence, R. I., has recently sold out the electrical house furnishing department of its business to the Geo. H. Thurston Company of the same place.

Messrs. M. K. Kendall & Co., formerly of Kendall & Slade, have established an office at No. 8 Oliver street, Boston, to carry on the business of contractors for electrical construction in the electric railway and lighting field. They will also deal in electrical supplies.

The Electric Heat Alarm Company, of Boston, is meeting with very flattering accounts relative to the action of its alarm, particularly from electric light stations. The little device is being used by people that believe that prevention is better than cure, and it has never been known to fail to report hot bearings, thus saving annoyance and money.

The Thomson Scientific Club, of Lynn, Mass., held its annual banquet in the Scientific Hall, and besides discussing many topics of interest to electrical men, the occasion was one that will be long remembered by the club. The committee of arrangements at the banquet consisted of Mr. H. S. Towner, H. S. Rogers, J. B. Blood and L. M. Schmidt.

The Kendall & Slade Company, of this city, has recently disbanded. Messrs. H. L. Slade & Co. are the successors of the old firm and will continue business at the old address, 134 Congress street, Boston. They will devote themselves to the electrical construction business, and are New England agents for the well known Habirshaw wire and other electrical specialties

The General Electric Company's New Factory.—It is rumored that the contract for the large factories of the new General Electric Company, to be located on the bank of the Saugus River, has been awarded to Woodbury & Leighton, of Boston, for $275,000. The buildings are to be of brick, of the most substantial construction, and the work will be pushed with all possible speed.

The Porter-Leavitt Electric Motor Company has recently moved to 124 Mitchell street, Providence, R. I. Its well known motors will in the future be constructed with interchangeable parts, so that any part becoming broken it can easily be replaced. This new departure will be appreciated by the trade generally. The company reports a splendid business for all grades of its manufacture.

The New Combination Street Car.—The Andrew patent combination street car had a very successful inauguration a few days ago on the line from Newton to Waltham. It can be used as a closed car with glass sides, or as an open car with slat curtains which roll automatically into the cornice of the car. Its seats are like those of a steam railroad car, and for comfort and safety it was pronounced a substantial advance.

The *Daily Palladium,* New Haven, Conn., has, among other improvements made in its plant, discarded the steam engine, and adopted electricity as the motive power for the presses. The Edison General Electric Company has installed one of its 12 h. p. motors in the Palladium building, and the paper observes: "The motor occupies very small space, is noiseless, easy to manage, and does its work quite as effectively as the cumbersome and more expensive steam engine, and at far less expense."

The American Electrical Arc Light Company, whose offices were formerly located at 71 Broadway, New York, has recently acquired a manufacturing site in New Haven, Conn., where it will commence the manufacturing of electrical apparatus. The company has been organized about three years, and is an outgrowth of the American Light Company, which, after manufacturing electric light goods for two years, became financially involved and was bought out by the new company. The present concern is a joint stock company organized under the New York State law with a capital stock of $1,000,000. The officers are J. W. Hinkley, of Poughkeepsie, N. Y., president, and Charles H. Slocum, of Poughkeepsie N. Y., secretary, treasurer and general manager.

Grade Crossings.—A difficult question is now coming into prominence before the Railroad Commissioners, that is, what to do with electric railroad crossings over steam railroads at grade. In their last report the Railroad Commissioners say: "Of all dangers at grade crossings there are none which compare in magnitude with those growing out of electric car service. A permit should not be granted to a street railway to run electric cars across steam railroad tracks unless it is practically a matter of necessity." There are in the State ninety crossings of street car lines where horses are now used, but where electricity will probably be substituted in the near future. At the hearing on the proposed crossing of the Nantasket Beach Railroad by the Hull Electric Railroad the Old Colony made a proposition that would settle the question in this particular case. The road offered to sell its Nantasket Beach branch to the electric railroad people, who might then run it as they saw fit. The road, the Old Colony maintains, is not a paying piece of property.

W. R. W.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
465 THE ROOKERY, CHICAGO, May 21, 1892.

The Pullman Company has decided to use simplex wire in rewiring its building and has ordered the necessary supply through Mr. George Cutter, of Chicago.

Kohler Brothers, representing the Eddy Electric Manufacturing Company, have removed their office from 341 Rookery Building to 1,417-1,418 Monadnock Building, corner Jackson and Dearborn streets.

The Chicago Electrical Association is growing steadily, securing a strong and desirable membership. At the last meeting the secretary, Mr. F. R. McBerty, read a paper on the "Sparking and Flashing of Dynamos."

Mr. A. B. Colton is nicely located in the new show rooms which he has fitted up for the M. C. Bullock company at 39 South Canal street, Chicago, and is on the outlook for orders for the Bullock-Corliss engine that is especially adapted for the heavy duty required in lighting and railway work.

The National Trade Press Association completed its organization on Thursday, and elected as president of the association Mr. W. A. Carroll, Western manager of the scientific American papers. The aim of the association is to advance the best interests of the advertising solicitors of trade publications.

The Telautograph.—Prof. Elisha Gray's telautograph, or writing telegraph, is to be commercially advanced by the Gray International Telautograph Company, with a capital of $1,000,000. The company has been incorporated with Frederick W. Cushing, Horace A. Cushing and Dr. James W. Chisholm as incorporators.

The Wagner Electric Manufacturing Company, of 1,822 Olive street, St. Louis, Mo., has installed a one horse power alternating current series wound motor in the First Presbyterian church, where it is used in driving a Sturtevant fan supplying the organ. The motor is a four-pole machine having self-oiling bar bearings and jacketed laminated fields.

The Stirling Company, Pullman Building, Chicago, has seven water-tube Stirling boilers in the handsome new power house just completed for the Minneapolis-St. Paul street railway lines. These boilers are of 300 h. p. each, with 18 inch steam and 22 inch exhaust pipes, planned on a basis of 150 pounds of steam pressure. The water used is supplied from an artesian well over 1,000 feet deep.

Mr. Wm. H. McKinlock, president of the Central Electric Company, has returned from a successful extended Western trip, having called upon many of his old friends and customers of his company and making many new ones. Mr. McKinlock secured an order for the entire underground electrical system of one of the larger Western cities, Okonite wire to be used, besides other valuable trade.

Mr. George Cutter, the electrical specialist of the West, found his factory business increasing so rapidly that more commodious work rooms were necessary, so he moved the machine shop to 315 South Canal street, Chicago, and added four skilled machinists. Mr. Cutter has one order on his books calling for $40,000 worth of shop work, and his specialty business is in so healthy a state that he has recently added two more traveling men to his staff.

Mr. C. J. Butler, manager of the Indiana Rubber and Insulated Wire Company, has moved his headquarters to Chicago in order to be nearer the base of operations. The factory will still remain at Jonesboro, Ind., and Mr. Butler will make flying trips there as occasion demands, but the major portion of his time will be passed among the heavy users of wire, who are appreciating the value of the excellent insulation the Indiana company is manufacturing.

Electric Model of a Coke Plant.—The Jones Bros. Electric Company, of Cincinnati, O., it is stated will make a complete model of the entire plant of the H. C. Frick Coke Company, of Scottdale, Pa., for exhibition at the World's Fair. The estimated cost of the model is between $3,000 and $4,000. It will occupy a space of about 20 by 50 feet, being made on a scale of one-twentieth of an inch to the foot, and will be an exact fac-simile of the original. All the machinery will be run by electric power.

Mr. H. G. Osborne will sever his connection with the Edison General Electric Company on June 1, and then assume the duties of secretary of the Bain Electric Manufacturing Company, 45 South Jefferson street, Chicago. In leaving the Edison company Mr. Osborne carries with him the best wishes of those with whom he has been connected, and a very strong indorsement from General Manager John I. Beggs; and his experience in practical work, both in dynamo and storage battery installation, as well as knowledge of the commercial value of electrical specialties, makes him a desirable secretary for the Bain company.

The Kester Arc Lamp and Manufacturing Company has secured attractive and commodious quarters in the new factory building located at 173 South Canal street, Chicago, and will occupy the entire seventh floor. Mr. J. F. Kester is the superintendent and general manager of the new company that has been formed primarily to manufacture Mr. Kester's new and simplified arc lamp that has given good satisfaction on incandescent and arc circuits. Later on the company may take up the manufacture of a new type of dynamo specially designed by Mr. Kester for train lighting in railway service and from which a current of 110 volts potential is secured at 98 revolutions.

Aluminium Bronze.—A metal possessing a rich golden color and susceptible of a high finish and having the strength and wearing qualities of steel is the perfected aluminium bronze of the J. J. Ryan Company, of Chicago, who are in receipt of many orders for various forms of castings, and especially for commutator segments made from this metal, which is also largely used for worms, gears, and similar parts of electric elevator machinery. As the Ryan foundry is the biggest one in the West, extending from 68 to 74 West Monroe street, supply dealers and dynamo manufacturers need have no hesitation in forwarding orders, as they can generally be filled the same or the following day.

The World's Fair at Chicago is to utilize ten times as much electricity as was generated at the Paris Exposition. From 18,000 to 22,000 electrical horse power will be used as motive and light power. About 120,000 incandescent lights have been provided for, and 7,000 arc lights. The electric plant will cost $1,500,000 and will be twice as large as any now in existence. Exhibitors are not to be called upon to furnish lights unless they require a different arrange-

ment from that provided by the construction department. The electric power will be conveyed over the grounds in a system of subways. As fifty separate contracts are to be let for the electric lighting, a variety of methods will in this way be demonstrated.

Incandescent Lights for the World's Fair.—Mr. George Westinghouse has made another bid for the incandescent lighting at the World's Fair and offers to furnish the required 92,622 lamps for $399,000, or at the rate of $4.25 per lamp, provided that he is permitted to use alternating currents alone. There was some question as to whether an injunction would not be brought against the Westinghouse company if it secured the contract, but it is said that Mr. Eugene Griffin, of the General Electric Company, has assured the committee that no such injunction will be brought. The General Electric Company has been asked to take the contract for half the lighting, but the whole matter is still unsettled.

Another supply house has entered the field in the belief that ample room exists in Chicago, and there is every indication that from the start success will attend its efforts. The members forming the new company are gentlemen well known to the electrical fraternity in the West, being old in the supply business. Mr. Walter C. McKinlock, till May 1 the manager of the Southern Electrical Supply Company, of St. Louis, is the organizer of the new company, which he has aptly christened the Enterprise Electric Company and he has brought with him Mr. F. P. Hill, who was associated with him in St. Louis and also Mr. W. F. Richardson, formerly with the Central Electric Company, of Chicago. These gentlemen are now rapidly fitting up the ground floor store, No. 6, in the Manhattan Building, 315 Dearborn street, Chicago, and will carry a complete line of heavy electrical supplies. The local agency for Kerite wire has been secured and a full line of sizes will be carried, so that no delay will occur in filling orders for this well-known insulation.

From Out of Town.—Among the visitors in Chicago this week were Mr. and Mrs. Charles D. Jenney, of Indianapolis. During Mr. Jenney's visit he purchased a number of new machinery tools, including a lathe of largest size, rendered necessary by the great increase in his motor and dynamo business. Mr. J. H. Mason, the general manager of the Simplex Electrical Company, of Boston, came in from the Northwest on Thursday. Captain Eugene Griffin and Mr. Samuel Insull, vice-presidents of the General Electric Company, Mr. George Westinghouse and Mr. C. A. Terry, of the Westinghouse Electric and Manufacturing Company, of Pittsburgh, were closeted with Chief Burnham on several occasions this week, when the bids for the incandescent lighting of the World's Fair was under consideration. Mr. F. W. Brigham, of the Atlantic Covering Company, Boston; Mr. George Mayo, of the Rockford Electric Manufacturing Company, Rockford, Ill.; J. Paul Gaylord and Lewis R. Schultz, of the Pennsylvania Electric Engineering Company, Philadelphia; Vice-President Daigh, of the National Electric Manufacturing Company, of Eau Claire, Wis.; Mr. George H. Finn and C. E. Carpenter, of the Carpenter Electric Heater Company, of St. Paul, Minn.

F. DE L.

News of the Week.

THE TELEPHONE.

The Nebraska Telephone Company is to expend about $300,000 in improvements on its plant in Omaha. Subways are to be put in, in laying which the company contemplates an outlay of about $35,000 this year. A new central exchange building is to be erected which will cost about $60,000. A new switchboard to cost $32,000 will be put in, and all the latest apparatus and devices for improved service and to protect the apparatus from lightning. It is expected to begin subway work by June 1.

The New England Telephone and Telegraph Company, it is stated, is contemplating running a long distance telephone wire from Burlington, Vt., to Bellows Falls, connecting with the Long Distance Telephone Company. It will be built by links. The circuit will be of metallic wire, and Vergennes will probably be connected with Burlington in the near future. Then a line will be extended to Middlebury, and so on until Bellows Falls is reached. This will give Burlington telephonic communication with all the large cities within a radius of 1,000 miles, or as far as it is possible to talk by the 'phone.

THE ELECTRIC LIGHT.

Somerset, Pa., has contracted for an electric light plant for incandescent and arc lighting.

Montello, Wis.—The Berlin and Montello Granite Company has recently installed a 25-light arc dynamo.

Boulder, Colo.—The Boulder Electric Light Company has decided to increase its plant by the addition of another large engine, boiler and incandescent dynamo.

Stafford Springs, Conn.—The new electric light company is rapidly placing its machinery in place and contemplates having its plant ready for operation by June 1.

The Tuscola Electric Light and Power Company, of Tuscola, Ill., is adding a new 150-h. p. Hamilton-Corliss engine to its power plant and expects to have it running by June 1.

The People's Edison Illuminating and Power Company, of Warwick, R. I., it is stated, will install an arc system by Oct. 1, and contemplates other improvements in its plant.

Orange, Mass.—Water power privileges have been recently acquired for the Orange electric light plant, and the intention is hereafter to run the same by water instead of steam power. Other improvements in the plant are contemplated.

Lexington, Va.—T. W. Shelton, W. H. Waddell and others have been awarded a contract for lighting the town by electricity, the plant to be commenced Sept. 1, 1892, and completed by Jan. 1, 1893, the franchise to be exclusive from that date for 10 years.

The Cincinnati Edison Electric Company has been awarded the contract for city lighting by a vote of the City Council, which ends one of the most vigorous fights which has ever taken place among electric lighting companies seeking to gain a contract.

The Pennsylvania Railroad Company is about to introduce a system of electric lights along each side of its entire line between New York and Chicago. The idea is to permit the running of trains at a high rate of speed at night with greater safety and it will be perfected in time for the World's Fair.

The Narragansett Electric Light Company, of Providence, R. I., has had a bill passed in its favor by the Rhode Island Legislature, granting it a 20-year franchise, for which it is to pay to the city three per cent. of its gross earnings. The company's franchise extends to the streets only that its wires and poles are now in and does not prevent rival companies from setting up plants for suburban service.

The Leominster Electric Light and Power Company, of Leominster, Mass., is making several important improvements in its plant, in the addition of new engines and boilers and a new dynamo for incandescent lighting. The company has the contract for furnishing the power for three years to the Fitchburg & Leominster Street Railway as soon as its electric system is ready for operation, which will be within a short time.

THE ELECTRIC RAILWAY.

The Ossining Street Railway, at Sing Sing, N. Y., will soon change its motive power to electricity.

Toronto, Can.—The City Council has decided to adopt the trolley system for the street car service.

The Lynn & Boston Railway Company has been granted permission to operate its road by electricity, and it is understood that work will begin at once on the erection of poles.

The Westinghouse Company has secured the contract for the entire electric equipment of the Woodlawn and West Side Railway Company, of Cleveland, one of the largest street car companies in the West.

Bloomington, Ill.—A stock company has been formed, and all the stock to the value of $100,000 has been taken by eight business and professional men, to construct an electric line to connect the "Big Four" depot at Bloomington with the business centre of Normal.

The Allison Manufacturing Company, of Philadelphia, has recently had built and equipped an electric tramway at its shops. The line is nearly a mile in length and is equipped with the latest appliances in the electrical line. At a recent trial exhibition of the system, the results, it is stated, were highly satisfactory.

Columbus, Ind.—The newly organized and incorporated Electric Street Railway Company, whose members are Messrs. Lucas, Keller, Brockman, W. W. and W. A. Mooney and others of the old Citizens' Electric Light Company, will petition the City Council for a franchise permitting them to use certain streets of the city for operating a line of electric street cars.

An Electric Railroad.—The Beaver & Ellwood Railroad from Ellwood to Ellwood Junction, a distance of three miles, is to be operated by electricity. The same tracks will be used as the present steam line now employs. The freight trains will have the tracks in the early mornings and evenings and during the day passenger cars will be run. It is expected to be in operation within a month.

Brooklyn, N. Y.—Cars were run on the Third Avenue line for the first time on Friday, May 20. President Lewis and a party composed of officials of the road and other gentlemen interested made a trip from Twenty-fifth street to Fort Hamilton, where lunch was served, and thence to the power station on Second avenue. The car ran very satisfactorily. On Monday the dummies were taken off and 28 electric cars placed in service.

LEGAL NOTES.

The Edison feeder and main case, which is so well known to the electrical public, has been before the U. S. Court for the Southern District of New Jersey, at Trenton, Judge Green, presiding, for some time. The arguments were finished on Monday of last week, but supplementary briefs are being prepared and will be submitted this week. The Edison Electric Light Company brought suit against Westinghouse, Church, Kerr & Co. for infringement of a patent granted to Thos. A. Edison, Sept. 19, 1882, on the use of feeders and a system of distribution. This case is one of considerable importance and the outcome will be watched for with interest.

Decision in the Delaware Telephone Suit—The suit of the State of Delaware *ex rel.* the Postal Telegraph Company against the Delaware and Atlantic Telephone Company, recently argued in the U. S. Circuit Court of Appeals before Judges Acheson, Butler and Green, on an appeal from the U. S. Circuit Court for the District of Delaware, has been decided and the judgment of the lower court in favor of the Postal Telegraph Company sustained. The respondent owned and operated a telephone exchange in Wilmington, Del., the Western Union Telegraph Company being one of the subscribers, and the relator, who owned and operated a telegraph system having its headquarters at the same place, applied to the respondent for similar privileges and was refused. The court held that telephone companies are governed by the same rules as all common carriers, and have no right to discriminate between individuals of classes which they undertake to serve, and any exclusive license to any party was therefore unlawful; that although one may have exclusive right to the use of a patent, as soon as he used such a patent as a means of conveyance then it is the business that is regulated.

PERSONALS.

Mr. M. J. Sullivan, editor of the *Street Railway Gazette*, of Chicago, has become proprietor of that journal.

Mr. Nikola Tesla's many friends will be sorry to learn that he has sustained a severe loss in the death of his mother, to whom he has been on a visit. Owing to this loss he is still detained in Montenegro.

Prof. Henry Smith Carhart, A. M., professor of physics and director of the physical laboratory of the University of Michigan, will go abroad June 1, partly in connection with his work as secretary of the Electrical Congress of the World's Fair.

Mr. James Smith, Jr., who was recently appointed by Governor Abbett of New Jersey as a member of the newly created Electrical Subway Commission, has resigned and State Treasurer George R. Gray had been appointed in his place by the Governor. The other members of the commission are Allen L. McDermott and Miles Ross.

In Memory of Jacob Barnsley.—The Charles Munson Belting Company, of Chicago, at a special meeting of the Board of Directors unanimously passed resolutions in reference to the death of Mr. Jacob Barnsley, the late superintendent of the company, expressing regret at the loss of so valuable an officer and keen appreciation of his many admirable qualities.

Mr. Louis Warfield, general manager and treasurer of the Detroit Electrical Works, was united in marriage recently to Miss Alice, daughter of Mr. and Mrs. Hugh McMillan, of Detroit, Mich. The wedding ceremony was performed at the residence of the bride's parents and was largely attended by friends of the bride and groom in Detroit and by a large number from various parts of the country.

Mr. C. C. Corbett, of Detroit, Mich., has been appointed to succeed Superintendent E. P. Wright, of the fifth district of the Western Union Telegraph Company, at Cleveland, O. Mr. Corbett will take charge of the district work on June 1, it is stated. The resignation of Mr. Wright on account of ill health was referred to in last week's issue of THE ELECTRICAL WORLD. He has filled the position in the Cleveland office for nearly thirty years. The district of which he has had charge comprises Indiana, Michigan and the northern half of Ohio. It contains over 2,000 offices now, but when Mr. Wright took charge of it the offices were only a few dozen in number. Together with George Hicks he invented and perfected the Hicks-Wright repeater and in many other ways demonstrated his inventive ability. His successor, Mr. Corbett, is also an old-time telegraph operator.

MISCELLANEOUS NOTES.

Aurora Borealis.—On Wednesday night, May 18, between the hours of 11 and 12 occurred another of the brilliant auroras that have been so prominent during the past months. It was peculiar for its flashing, alternating character. Prof. Pupin, of Columbia College compares it to an electrical discharge in a highly evacuated Crookes tube containing some hydrocarbon gas, such as alcohol or ether.

Another Electrocution.—The ninth electrocution took place at Auburn on the morning of May 18, when the murderer, Tice, met his death. This is the second electrocution at Auburn, and the same apparatus was employed as that used to kill Kemmler, but a higher voltage was tried. The electrocution was successful in every particular and the victim died an instantaneous and painless death.

Industrial and Trade Notes.

The J. H. McEwen Manufacturing Company, of Ridgeway, Pa., is installing a 100-h. p. single cylinder engine in the Pineville, Ky., electric light station.

The Central Electric Company report considerable activity in the sale of Okonite wire, their orders for the current week aggregating one half million feet, Manson and Okonite tape being in fair demand, as well.

The American Motor and Dynamo Company, of Denver, Colo., incorporated about a year ago by Denver capitalists, recently filed a certificate of full paid up stock, and has leased a building for manufacturing purposes at 1,337 Lawrence street, where it will manufacture motors and dynamos especially adapted for light and power purposes in the mines and mining districts of Colorado.

Seavey & Co., of Boston, have recently patented a lamp shade and holder for incandescent lamps, the peculiarity of which consists in its adaptability for use in billiard rooms, offices, etc. As a billiard table shade it is particularly valuable, being adjustable at any desired angle, and is so arranged with openings that while the table is illuminated and the eyes shaded, the counters are fully exposed to view, and other parts of the room lighted up.

The Electric Appliance Company has found a new use for its flexible conduit and in addition to filling large orders for interior conduit work is selling a large amount as a substitute for hard rubber tube. It is particularly adapted for this purpose on account of its flexibility, as it can be bent in any shape without injury. It also has another advantage over rubber, being non-combustible and unaffected by atmospheric action, oils or acids. As it comes in long lengths it can be cut and used in any lengths desired, thus avoiding the waste which is unavoidable with hard rubber tube or any substitute for it that comes in short lengths.

J. G. White & Co., of New York, report that their contract business is in a flourishing condition. They are completing 5 miles of track and overhead work at Wilmington, N. C., and have under way 4½ miles of octagonal and iron pole construction at Yonkers, N. Y., 5 miles of octoginal pole construction at Steinway, L. I., and 7½ miles of overhead work for the Baltimore Traction Company, of Baltimore. Contracts have been signed with the Central Railway, of Baltimore, for 11 miles of iron pole work, with the Pawtucket Street Railway for 3 miles overhead work with octagonal poles, and with the New Orleans & Carrollton Railroad for 16 miles with iron poles.

The Detroit Electrical Works have opened a New York office at No. 18 Cortlandt street, rooms 11 and 311, Telephone Building. This office is in charge of Mr. T. W. Warfield as district manager. The company has also opened an office in Boston at No. 23 Fiske Building. This move has been made necessary on account of the great press of the company's Eastern business, the demand for goods of this company's manufacture being very large. The opening of Eastern offices will prove of great convenience to the trade, inasmuch as information respecting the company's apparatus may be obtained on short notice. Taken in connection with the large extensions which the company is making to its facilities for manufacturing, it will be enabled to handle a large business in a manner that cannot fail to be satisfactory to its patrons.

The McCreary Electrical Specialty Company, of 136 Liberty street, New York, has recently brought out and placed upon the market a three-light ceiling fixture for reflector and half shades, and an aluminium half reflector shade, both of which are meeting with great favor and ready sales. The former is designed as a low fixture for use in places where the height of the ceiling does not permit the use of fixtures of ordinary size, and in design is very ornamental and makes an attractive fixture for store windows and in small rooms with low ceilings, under church and theatre galleries, etc. The latter is made of aluminium, is highly polished on the inside and covered with dark green enamel, and is designed for the interior of show windows and cases, over pictures, stage and foot lights, and on desk portables with flexible arms. It being movable around the lamp, all the light can be thown in any direction required.

Business Notices.

Battery Cut-Out, Cheap.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

Molds for casting battery zincs are made of iron and steel. We have just completed sets for the "D'Infreville Patent Wasteless Zinc," costing over $40 each. H. Brooke, 44 Barclay street.

Thirty-five-light, 2,000-c. p. American arc dynamo, in good condition, for sale at a bargain; also 750-light Westinghouse alternator, with station appliances. Address E. T. Pardee, 10 Butler Building, Syracuse, N. Y.

Type 15 L. of the Consolidated Electric Storage Company yields four hundred ampère hours at a continuous discharge of 30 ampères. It is almost identical in size and weight with the 15 L. of the Accumulator Company, and will fit the 15 L. jar of that company.

Burlington Route—New Service.—A through Pullman sleeping car, Chicago to San Francisco, is a feature of the Burlington's new service. This car leaves Chicago daily on the fast train at 1:00 P. M., and runs via Denver, Colorado Springs, Leadville, Glenwood Springs, Salt Lake City and Ogden, arriving in San Francisco at 11:45 A. M., less than four days *en route*.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

[In Charge of W. A. Rosenbaum, 177 Times Bldg., N. Y.]

U. S. PATENTS ISSUED MAY 17, 1892.

474,826. Incandescent-Lamp Socket; Harry J. Gutman, Des Moines, Ia. Application filed June 29, 1891. This invention has for its object the provision of means by which a lamp may be readily and firmly secured to and held by the socket and also readily detached therefrom, and the provision of means by which the current may be cut on or off from the filament by a slight pressure of the hand, the key by which this result is accomplished being of the most simple construction and so held that no jarring of the parts will dislocate the key when the latter assumes the position by which the current is cut off.

474,828. Medical Battery; Philip Hathaway, New York. Application filed April 2, 1891. The combination of a close-sealed electric battery held in position between two spring contacts, an induction coil electrically connected with said battery, a vibrator adapted to be actuated by said coil, a container to hold said battery and coil, and two metal electrodes in the circuit affixed to the outside of said container.

474,835. Time Call; James Jones and James Jones, Jr., Brooklyn, N. Y. Application filed July 31, 1891. The combination, in an electric alarm mechanism, of a spring connected to one part of the alarm circuit, a movable circuit closer connected to the other part of the electric circuit, and having a check-holding projection that is not adapted to receive the checks until such circuit closer and checkholder have been moved to close the electric circuit to the springs.

474,847. Standard for Electric Wires; Edmund C. Morgan, Chicago, Ill. Application filed Oct. 19, 1891. This invention consists of an extensible standard for supporting electric wires and similar purposes, comprising a supporting-post, an independent frame provided with a holder or clamp for the device to be supported, and a screw threaded rod resting loosely against one of the above mentioned parts and carrying a nut which supports the other of such parts.

No. 474,912.—Electric Battery.

474,848. Armature for Electric Motors; Edmund C. Morgan, Chicago, Ill. Application filed Dec. 12, 1891. This is an armature comprising a shaft, end plates or heads, a cylindrical sleeve clamped between said end plates or heads, soft iron cores, and coils surrounding the same inclosed within the sleeve and end plates and supported by the latter.

474,852. Signaling Apparatus; Bernice J. Noyes, Boston, Mass. Application filed Sept. 17, 1889. In an electric circuit, a signal receiving station containing a register and a bell operatively connected with the said circuit, and responsive to the signal impulses, a controlling device for rendering said bell non-responsive, and an electromagnet controlling the action of said controlling device, and responsive to a distinguishing impulse combined with a signal transmitter, also connected in said circuit and contained in a box, and a circuit changer for transmitting the said distinguishing impulse to effect the operation of the electromagnet.

474,853. Signaling Apparatus; Bernice J. Noyes, Boston, Mass. Application filed Sept. 17, 1889. In an electric circuit, a signal-receiving station containing a register and a bell operatively connected with the said circuit and normally responsive to the signal impulses, a controlling device for rendering said bell non-responsive, consisting of a shunt switch and retarding device for it, and an electric magnet for said shunt switch responsive to a distinguishing impulse, combined with a signal transmitter, also connected with said circuit and contained in a box, and a circuit changer for transmitting said distinguishing impulse to effect the operation of said electro-magnet.

474,854. Trunk-Line System; Joseph L. O'Connell, Chicago, Ill. Application filed Oct. 4, 1888. Trunk-lines between two switch boards or sub-stations divided into two divisions, one division extending from a common ground wire including resistance at one station, each through a different spring-jack switch, and thence each to the other sub-station, and each through a different spring-jack switch, and thence to a common line including an operator's telephone, the other division extending from a common line including resistance at the last sub-station, each through a different spring-jack switch, and thence each to the other of first sub-station, thence to a common line including the listening operator's telephone, in combination with switching apparatus, whereby the operators may communicate over the different trunk lines, the trunk lines being adapted to making the connections between different telephone lines terminating at the different stations.

474,857. Electric-Motor Mechanism; Elbert B. Phillips, Cleveland, O. Application filed Dec. 24, 1890. The combination, with a car, of a propelling motor connected with the driving axle by means of sun-and-p'anet gearing adapted to be engaged or allowed to run idly by arresting or freeing a movable part, and an adjustable gripper for said part having a spring or buffer through which the said gripper is held from rotation, so that when the gripper is applied it arrests the part with yielding resistance.

474,877. Cupping-Glass with Electrical Attachment; Frances Thomas, San Francisco, Cal. Application filed Sept. 9, 1891. A surgical instrument consisting of a cupping device having means to electrify the parts to which it is applied.

474,907. Hotel Call System; Grant P. Greene, Chicago, Ill. Application filed Oct. 31, 1891. The object of this invention is to provide a system whereby each guest may by means of a dial and push-button indicate different services required upon the annunciator in the hotel office. When one annunciator is used, it is provided with a separate indication or number for each room, and a special indication for each want or service required, these special indications serving for all the rooms in the hotel; the circuits are so arranged that a guest, upon operating the push-button and dial in his room, indicates on the annunciator the number of his room and the particular service required, the service indicated being determined by the particular point of the dial in the room to which the indicator of the dial is directed before the push-button is pressed.

474,912. Electric Battery; Alphonso S. Keating, Corry, Pa. Application filed Sept. 29, 1891. In a battery cell, the combination with a battery element of an oil-receptacle attached to the element or formed thereupon at a point above the surface of the solution. (See illustration.)

474,921. Electric Switch; Gustav Pfannkuche, Cleveland, O. Application filed March 1, 1890. The object of this invention is to produce a switch by means of which a circuit carrying a current of high electromotive force can be broken with great rapidity and the contacts so widely separated that the destructive sparking which occurs in other switches is in a great measure reduced.

474,945. System of Signaling; Henry A. Chase, Boston, Mass. Application filed Dec. 18, 1891. In a signaling system the combination of the following instrumentalities: A signal transmitting mechanism, a signal receiving or recording mechanism, an electric circuit connecting said mechanisms, a motor mechanism to operate the receiving or recording mechanism, a speed-changing device to positively vary the rate of movement of the motor mechanism, and thereby the rate of movement of the receiving or recording mechanism, and means in the electric circuit to effect the operation of the speed changing device.

474,953. Automatic Potential Regulator for Electric Currents; Alvinis 'Lonzo Ellis, Chicago, Ill. Application filed March 9, 1891. In an automatic potential regulator for electric currents, the combination of a voltmeter in the main circuit, with a needle projecting therefrom, opposed contacts on the opposite sides of such needle, circuits connected with each of said contacts, and motors, one in each of said circuits, and an exciter dynamo, the motors adapted one to set in operation mechanism to increase the other to diminish, the strength of the field of the exciting dynamo, and a resistance in series with the field magnets of the exciter included in such mechanism.

474,957. Rheostat; Albert B. Herrick, Bayonne, N. J. Application filed Oct. 12, 1891. The combination, in a rheostat, of two stationary insulating frames or open structures, a resistance conductor wound on each frame, and a switch device the opposite ends of which are movable over the resistance conductors, said conductors being uninsulated in the path of movement of the switch device.

474,960. Terminal and Safety-Catch Connection; Joseph Hutchinson, New York. Application filed Oct. 12, 1891. The combination with main and branch terminals of an insulating screen, the positive main and branch terminals being on one side of said screen and the negative main and branch terminals being on the opposite side of said screen.

474,964. Electrically Heated Matrix-Press; Willis Mitchell, Malden, Mass. Application filed Dec. 4, 1891. In a matrix press, the combination of a platen having studs formed on it with electric heaters fitting on the studs, each of the said heaters being formed of a wire wound on successive cylindrical or conoidal walls, and the said wire being in an electric circuit.

474,980. Burglar Alarm; Robert G. Vassar, New York. Application filed April 11, 1887. The combination, with a laterally movable bolt, an alarm mechanism and mechanical releasing devices for the latter arranged in the path of the laterally movable bolt, of an electric circuit controller arranged in the path of the laterally movable bolt and an electric circuit connecting the same with an electromagnetic alarm or indicator.

474,984. Electric Locomotive; Charles Brown, of Naples, Italy, and Gustav Jacob Melms, Chicago, Ill. Application filed March 7, 1890. A worm gearing, comprising a worm, a driven shaft provided with two discs, each having a plurality of anti-friction rollers engaging the worm, said discs being adapted to turn or oscillate upon the shaft and means connecting the discs with the shaft, affording an equilibrium of strain upon the discs.

475,066. Electric Signal for Engines; James C. Ricketson, Milwaukee, Wis. Application filed Aug. 31, 1885. The combination of a revolving shaft having a spur attached thereto, a pair of distant signals each electrically connected to push-buttons, a pair of movable push-rods, one located on each side of the shaft adjacent to said push-buttons and bearing lugs normally located in the path of motion of the spur, a hanger supported midway between said push-rods, and a lever pivoted to the hanger, and provided with cords at each end, whereby the said lever may be brought to a horizontal position, when required, so as to force the push-rods apart out of contact with the spur.

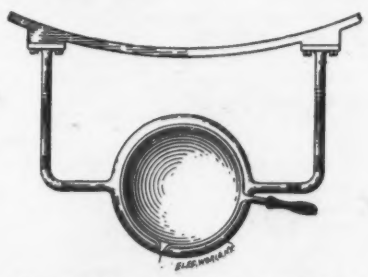
475,107. Electric Railway; John W. Grantland and Gilbert L. Parker, Philadelphia, Pa. Application filed Jan. 14, 1892. In an electric railway, a subway or conduit, a hollow conductor means for forcing a heating medium through said conductor, and relay heating stations connected with said conductor.

475,137. Electric Lock; Frederick Morgenthaler, Brooklyn, N. Y. Application filed Sept. 10, 1891. The combination, with the lock case, and magnet and armature arranged therein, of a laterally extending latch pivoted on the case and having one end projecting into the case and a movable bar connected with the armature and adjustably connected with the latch, so that the throw of the latter may be regulated.

475,159. Armature for Dynamo-Electric Machines; Sidney H. Short, Cleveland, O. Application filed Nov. 6, 1890. A ring armature consisting of a core composed of magnetically independent laminæ, rivets extending through the laminæ, and insulating washers encircling the rivets and separating the laminæ, in combination with end pieces, each consisting of an annulus and a hub joined by radial arms, spacing blocks interposed between the end pieces and core, bolts passing through the end pieces, spacing blocks and laminæ, and insulating washers encircling the bolts and separating the laminæ.

475,160. Electric Railway Motor; Sidney H. Short, Cleveland, O. Application filed Dec. 4, 1890. In an electric motor car, the combination, with two electric motors having rotatable armatures and field magnets, of two clutches, one for each field magnet, for impeding and arresting the rotation of the latter, and mechanism for operating both clutches simultaneously.

475,169. Electrically Heated Curling Iron; Arthur Henry Watson and Frank Emanuel Antonini, London, England. Application filed Dec. 1, 1891. The combination, with tongs or irons for curling, goffering, etc., of an electric heater, conductors, insulators, a switch placed inside the curling or goffering jaws and handles for the purpose of imparting heat to them while in use and a push rod arranged longitudinally of one of the handles for actuating said switch.



No. 475,189.—Electric Heater.

475,178. Electrical Forge; George D. Burton, of Boston, Mass. Application filed May 6, 1891. An electric forge having an electric current converter, two pivoted intermediate arms separately connected with opposite terminals thereof, means for adjusting said arms on their pivot, a second intermediate arm pivotally connected with one of the first intermediate arms, an electrode arm connected to the outer end of said second intermediate arm by a universal joint and an electrode arm connected with the outer end of one of the first intermediate arms.

475,179. Distributing Apparatus for Heating Currents; George D. Burton, of Boston, Mass. Application filed May 14, 1891. An apparatus for distributing electric currents for heating purposes, having a current converter provided with exterior rings constituting the positive and negative poles, a secondary current converter provided with exterior rings constituting the positive and negative poles, conductors connecting the primary with the secondary converter, an electric heater, and conductors connecting the rings of the secondary converter with the heater.

475,180. Electric Connector for Converters; George D. Burton, Boston, Mass. Application filed May 14, 1891. The combination, with a converter ring, of a connector consisting of a clamp provided with a binding post or socket and with hooks engaging said ring.

475,181. Electrical Metal Heater; George D. Burton, Boston, Mass. Application filed May 26, 1891. An electric metal working apparatus, having two converter rings constituting the positive and negative poles, two conductive brackets connected, respectively, to said rings and provided with horizontal arms, two clamps adjustable toward and from each other on said arms, two standards on one of said arms, a shaft journaled in said standards and provided with a clamp at one end, and means for rotating said shaft.

475,182. Method of Electrical Metal Working; George D. Burton, Boston, Mass. Application filed June 29, 1891. The method of making a metal forging, which consists in subjecting a rolled or drawn bar or sheet to be forged to the action of an electric heating current until its interior is raised to a plastic forging heat and maintaining the temperature of its exterior so far below that of the interior as to preserve its form and homogeneous character, said heating operation being performed within a period which will avoid the destruction of the external skin of the metal by oxidation and then forging or shaping the bar or sheet into the desired irregular shape or article by bending or shaping the external skin of the bar over the internal plastic metal to form the surface of the finished article or forged part thereof without breaking or destroying said skin.

475,183. Method of Electrical Metal Working; George D. Burton, Boston, Mass. Application filed July 1, 1891. The method of heating desired portions of a bar of metal spanning the space between electrodes of opposite polarity, which consists in passing a heating current of electricity through the bar and applying to a portion of the bar between the electrodes while the current is passing there through a conductor which diminishes the resistance of the part of the bar which it bridges over and retards or prevents its being heated there.

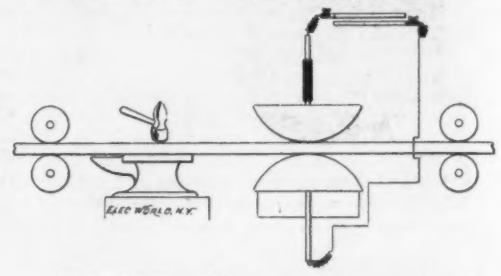
475,184. Electrical Converter; George D. Barton, Boston Mass. Application filed May 21, 1891. An apparatus for electric heating, of metal holders arranged to hold the metal to be heated, with two converters arranged to hold the metal to be heated, with two converters arranged to furnish electric currents of different potential, and intervening connecting mechanism arranged to connect and disconnect either of said converters from the metal holders at the will of the operator.

475,185. Electric Metal Heater; George D. Burton, Boston, and Edwin E. Angell, Somerville, Mass. Application filed Feb. 14, 1891. A machine for heating metal, having an upper series of adjustable arms bearing electrodes all of the same polarity, a lower series of similar arms of opposite polarity to the upper series and disposed in alignment therewith, an electric circuit, and mechanism for adjusting said upper arms.

475,186. Electric Forge; George D. Burton, Boston, and Edwin E. Angell, Somerville, Mass. Application filed May 25, 1891. An electric forge, having two conductive arms connected with opposite electric poles and clamps disposed on said arms, each of said clamps being composed of a fixed member and an oscillating member pivoted thereto, said members having clamping jaws above and below the pivot and one jaw of each clamp having a cam and means for actuating the cams.

475,187. Apparatus for Cooking by Electricity; George D. Burton, Boston, and Edwin E. Angell, Somerville, Mass. Application filed May 28, 1891. An electric cooking apparatus, having two converter rings constituting opposite electric poles, two conductive brackets attached, respectively, to said rings, and provided with horizontal arms, two clamps or holders adjustable on said arms, and provided with clamping jaws and a grate supported by said clamps, and serving to close the circuit between them.

475,188. Metal Heating Apparatus; George D. Burton, Boston, and Edwin E. Angell, Somerville, Mass. Application filed May 28, 1891. An electric forge having two electrodes connected with opposite electric poles, and consisting of carbon blocks having their adjacent ends shaped to fit a bar of metal to be clamped between them, and holders for said blocks.



No. 475,191.—Flexible Electrode.

475,189. Electric Heater; George D. Burton, Boston, and Edwin E. Angell, Somerville, Mass. Application filed May 29 1891. An electric heater having a heating-pot composed of material having a comparatively high current resistance, and provided with laterally projecting arms, and conductors for a heating current connected with said arms and with opposite electric poles. (See illustration.)

475,190. Electric Cooking Apparatus; George D. Burton, Boston, and Edwin E. Angell, Somerville, Mass. Application filed May 29, 1891. An electric cooking apparatus having two conductive clamps or holders connected with opposite electric poles, a radiating plate, of greater resistance than the holders, serving to close the circuit between them, and a holder for a cooking utensil disposed adjacent to said plate for holding said utensil within the heating influence thereof, said holder for the cooking utensil comprising a base provided with upward and inwardly extending arms having notches to be engaged by the cooking utensil.

475,191. Flexible Electrode; George D. Burton, Boston, and Edwin E. Angell, Somerville, Mass. Application filed June 26, 1891. An electrode for an electric heater, consisting of a frame and a series of superposed flexible elastic bowed contact-plates connected at their opposite ends to said frame. (See illustration.)

475,192. Electric Metal Heater; George D. Burton, Boston, and Edwin E. Angell, Somerville, Mass. Application filed Aug. 3, 1891. An electric current converter having angular positive and negative rings for distributing the induced current and a number of electric heaters attached to the straight portions of said rings.

475,193. Electric Metal Twister; George D. Burton, Boston, and Edwin E. Angell, Somerville, Mass. Application filed Aug. 22, 1891. An electric bar-twisting apparatus having two standards or supports connected with opposite electric poles, two tubular bar-holders disposed in alignment in said supports, each of said holders being open at both ends for the free passage of a bar to be heated and having a conductive bar clamp for grasping the bar, and means for rotating one of said tubular bar-holders.

475,194. Electric Metal Bending Apparatus; George D. Burton, Boston, and Edwin E. Angell, Somerville, Mass. Application filed Aug. 24, 1891. An electric metal working apparatus, having an electric converter, electrodes connected with the positive and negative poles thereof, slotted standards attached to said electrodes, journal boxes sliding in the slots of said standards, rolls journaled on said journal boxes, and springs for regulating the tension of the adjustable rolls.

475,195. Electrical Forge; George D. Burton, Boston, and Edwin E. Angell, Somerville, Mass. Application filed Aug. 25, 1891. An electric forge having an electrode head provided with a number of sockets for receiving the ends of the bars to be heated, another electrode consisting of a slotted head provided with a number of cheeks and a number of clamping screws opposite said cheeks for clamping said bars therein, and conductors connecting said electrodes with the source of a heating current.

475,196. Automatic Electric Forge; George D. Burton, Boston, and Edwin E. Angell, Somerville, Mass. Application filed Sept. 16, 1891. An electric forge having a positive electrode for contact with a bar to be heated, a negative electrode also for contact with said bar, one of said electrodes being provided with an opening and with a latching contact pin, and electric conductors connected with said electrodes for conveying a heating current of electricity.

475,232. Converting System for Electric Metal Heating; George D. Burton, Boston, Mass., Arthur H. Eddy, Hartford, and George T. Briggs, Windsor, Conn. Application filed Sept. 15, 1891. An electric converter for converting electric currents of high potential into those of low potential by induction, provided with metal holders in its secondary circuit arranged to hold therein the article to be heated, an alternating current dynamo connected to the primary circuit of said converter, an exciter dynamo connected to the field coils of said first dynamo and arranged to energize the field magnets thereof, and a rheostat interposed in the electric field circuit of said exciter dynamo and adapted to regulate the current of excitation of the fields of said first dynamo.

475,255. Rheostat; Walter A. Sterling, Denver, Col. Application filed Nov. 6, 1891. An incandescent electric lamp circuit having means interposed therein for controlling the brilliancy of the light, said means consisting of a vessel containing a suitable acid solution, said vessel consisting of a body composed of glass or other suitable non-conductor of the electric current, having a metallic top and bottom, a metal stem terminating at its bottom in a suitable metallic contact plate and passing up through the top of the vessel, said stem being adjustable and the top of the vessel being provided with means for supporting the same in any desired position, the bottom of the vessel being provided with a leaf contact spring, and the metallic top and bottom parts each provided with a binding post to which the circuit wires respectively lead.

475,264. Electric Metal Heater; George D. Burton, Boston, Mass. Application filed Aug. 3, 1891. An electric heater having a work bench, an endless electric converter disposed beneath said bench and having positive and negative rings for distributing the electric current and a number of heaters proper connected with said rings and disposed over said bench.

475,286. Electric Lamp Holder; Joseph B. Moore, Minneapolis, Minn. Application filed . an. 19, 1891. An electric lamp holder consisting of a plate having a portion swiveled upon the forward end thereof, and means for securing the lamp thereto, said swivel and lamp adapted to rotate about the end of said plate.

Copies of the specifications and drawings complete of any patent mentioned in this record—or of any other patent issued since 1886—can be had for 25 cents. Give date and number of patent desired and address The W. J. Johnston Co., Ltd., Times Building, N. Y.